THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
HYDRILLA ERADICATION PROGRAM
ANNUAL PROGRESS REPORT 2004

PROTECTING CALIFORNIA'S WATERWAYS

INTRODUCTION

This report covers the progress of the California Department of Food and Agriculture (CDFA) Hydrilla (*Hydrilla verticillata*) Eradication Program in 2004. The report begins with a brief history and overview of the program and then describes each of the current, active eradication projects in detail, followed by a section describing the CDFA's annual hydrilla survey of the Sacramento/San Joaquin River Delta and cooperation with the California Department of Boating and Waterways' remote sensing project in the Delta. This report also includes results of any water monitoring studies conducted in response to public requests; water monitoring conducted to comply with the National Pollutant Discharge Elimination System General Permit is published in a separate report. This report also includes a copy of the Hydrilla Eradication Program's Best Management Practices (Appendix I).

The CDFA is the lead agency in California for the eradication of hydrilla[1]. The CDFA conducts the Hydrilla Eradication Program with the specific goal of eradicating hydrilla from California in order to protect the state's water resources from this invasive, noxious weed. As the lead agency, the CDFA administers the Hydrilla Eradication Program, but does so in cooperation with the local county agricultural commissioners and other federal, state, county, and city agencies, Native American tribes, and private individuals and entities. In addition, the CDFA Hydrilla Eradication Program received financial and in-kind support in 2004 from the California Department of Boating and Waterways, California Department of Water Resources, United States Department of the Interior-Bureau of Reclamation, United States Army Corps of Engineers-Eastman Lake, Yolo County Flood Control and Water Conservation District, Lake County Department of Agriculture, and Lake County Department of Public Works.

The CDFA is committed to an "early detection and rapid response" strategy for the eradication of hydrilla. Detecting hydrilla in an "incipient" stage of invasion allows for the eradication process to proceed with less overall cost and less environmental impact than would be the case if hydrilla were detected in later stages of invasion. "Rapid response" involves bringing the most effective eradication methods that are appropriate to a given site and situation to bear in a timely manner. There are many examples in this document of "early detection and rapid response," and the CDFA considers this to be one of the keys to the success of the Hydrilla Eradication Program.

[1] California Food and Agricultural Code, Sections 6048 and 7271.

HISTORY AND OVERVIEW OF THE PROGRAM

Hydrilla is an invasive, submersed, non-native aquatic plant that is recognized by the State of California to be a serious, noxious aquatic weed that is a threat to the water resources of the state. Hydrilla can reduce water storage capacity of lakes, ponds, and reservoirs; impede movement in streams, canals, and drains; impede water control structures and choke hydroelectric generators; impede navigation; degrade fish and wildlife habitat; and endanger public health by reducing water flow and producing mosquito breeding habitat.

Hydrilla has been found in various places in the United States, including California. The dioecious[2] form of hydrilla was first identified in Florida in the 1960s, where it is believed to have been introduced in the 1950s. This infestation spread throughout the southeastern United States, Texas and Arizona. It was first found in California in 1976 in a 31-acre man-made lake in Marysville, Yuba County. The monoecious form was first detected in the Potomac River, near Washington, D.C. in the 1980s. It has since spread into a number of the southern states, into Washington State, and was first found in California in 1993 at an aquatic nursery in Visalia, Tulare County.

In 1977, after the first California hydrilla find, the California Legislature mandated[3] that the CDFA Secretary initiate a survey and detection program for hydrilla, and to eradicate hydrilla wherever feasible[4]. In 1985, after hydrilla was found in Redding, near the Sacramento River, the Governor of the State of California declared a "State of Emergency" to eradicate hydrilla[5]. In 1994, the CDFA Secretary declared an "emergency situation" in regard to the hydrilla infestation discovered in that year in Clear Lake[6]. Similar declarations have been issued for most of the current hydrilla infestations[7].

Since 1976, hydrilla has been introduced into California waterways 29 separate times, in 18 counties[8] (not counting detections in plant nurseries - see next paragraph). Of these 29 separate hydrilla introductions, the Hydrilla Eradication Program has eradicated hydrilla from 19 introduction sites in the following 12 counties: Los Angeles, Monterey, Riverside, San Bernardino, San Diego, San Francisco, Santa Barbara, Shasta, Sonoma, Sutter, Tulare and Yuba (Plate 1 and Table 1). The Hydrilla Eradication Program is currently eradicating[9] hydrilla from eleven locations in the following ten counties: Calaveras, Imperial, Lake, Los Angeles, Madera, Mariposa, Nevada, Shasta, Tulare, and Yuba.

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[2] The dioecious form of hydrilla has flowers of one sex only on each genetic individual. Monoecious individuals have individual flowers with only staminate or pistillate parts, but these occur on the same plant. Dioecious plants often branch freely near the water surface, forming large submerged mats near the water surface. In contrast, monoecious plants tend to branch freely near the rooting point, producing many stolons and a forest of vertical shoots, which can fill the entire water column with plant material. The genetic or ecological significance of this apparent dimorphism is unknown.

[3] California Food and Agricultural Code, Article 9, Section 6048.

[4] A Hydrilla Science Advisory Panel was convened after each hydrilla outbreak. These panels have always found hydrilla eradication to be feasible.

[5] "Proclamation of a State of Emergency," issued by Governor George Deukmejian, October 23, 1985; terminated October 23, 1989.

[6] "Proclamation of a Project Regarding the Eradication of Hydrilla," issued by CDFA Secretary Henry Voss, August 12, 1994.

[7] Calaveras, Madera, Mariposa, Nevada, Shasta, and Tulare counties.

[8] The CDFA considers hydrilla infestations to be separate introductions if they appear more than two or three years apart.

[9] California Code of Regulations, Title 3, Division 4, Sections 3281 and 3410; California Code of Regulations, Section 3962; CDFA Plant Quarantine Manual, Section 3410.

Hydrilla has been detected in plant nurseries and aquaculture vendors five times, including twice in 2004. In March 2004, hydrilla was detected in a plant nursery in northern Los Angeles County, and in November, hydrilla was also detected in an aquaculture wholesaler in Alameda County. In each case, the county department of agriculture took the lead in removing all hydrilla plants and plant parts from the infested area, and CDFA Pest Exclusion Branch and Hydrilla Eradication Program personnel worked with the vendor to prevent reintroductions.

Every year, program crews survey all known infested waterways, and high-risk lakes[10], ponds, reservoirs, streams, canals, and other waterways in the state. High-risk areas include the Sacramento/San Joaquin River Delta, other high recreational-use water bodies, and waterways within quarantine zones[11]. Surveys are conducted from shore, from watercraft, or by divers[12]. Surveys generally start when the water temperature climbs above 10 degrees C[13] (50 degrees F[14]) in the spring, and when water-flows in rivers and creeks have diminished to a safe level, and end when water temperatures fall below 10 degrees C in the fall because active growth of hydrilla occurs between 10 degrees C and 35 degrees C (DiTomaso and Healy 2003, page 102). The Hydrilla Eradication Program also follows up on all reports from the public on potential new infestations. Three new hydrilla-infested sites were found in 2004 in an aquatic nursery in Los Angeles County, in a waste disposal facility in Nevada County, and in an aquatic wholesaler in Alameda County (Table 1).

The Hydrilla Eradication Program uses an integrated pest management approach to eradicating hydrilla. In 2004, the Program used (alone or in combination) the following eradication methods: manual removal, small scale dredging, biological control, and aquatic herbicides. The aquatic herbicide of choice was fluridone slow release pellet formulation[15] applied at 90 ppb to 150 ppb[16], depending upon the size of the water body. Other herbicides used in particular situations (see Best Management Practices, Appendix I) include copper ethylenediamine liquid formulation[17] (applied at one ppm[18]) and a fluridone liquid formulation[19]. In the past, the Program has also used water draw down and drying of the hydrosoil, followed by soil fumigation; large and small scale

[10] High-risk lakes, streams, etc. are those within five miles of Clear Lake, one mile either side of the Sacramento River near the Riverview Golf Course, three miles of the Yuba canal, and one mile of Bear Creek, the west fork of the Chowchilla River, and the Springville ponds.

[11] Quarantine zones are established by declaration of the CDFA Secretary and are areas within eradication areas that have restrictions as to water use, access, or the intensity of survey.

[12] Surveys are conducted by two methods, visual search of the water column and physical samples. Trained biologists and support staff conduct visual searches to locate individual plants or mats that are visible in the water column or on the water surface. The crews conduct the visual searches from boats, canoes, or kayaks; by wading in shallow streams and lakesides; and by swimming using sight buoys and face masks, depending upon the circumstances. Because visual searches from the surface are sometimes hampered by poor visibility, the program occasionally contracts divers for underwater surveys. Physical samples are taken using a modified grappling hook, usually thrown from a boat or canoe. Personnel trained in identifying hydrilla carefully examine the retrieved plant material. If hydrilla is found by visual searches or bottom samples, the number of plants or size of the infestation is recorded along with the physical location (by using global positioning system technology and measured from known landmarks). Representative specimens from new locations are sent to the CDFA Plant Pest Diagnostic Center, Botany Laboratory for confirmation.

[13] C = Centigrade.

[14] F= Fahrenheit.

[15] Sonar® SRP brand, SePRO Corporation.

[16] One ppb = one part per billion = one microgram per liter.

[17] Komeen® brand, Griffin Corporation.

[18] One ppm = one part per million = one milligram per liter.

[19] Sonar® AS brand, SePRO Corporation.

dredging, and lining and burying as eradication methods (see Best Management Practices, Appendix I).

All known, infested sites are intensively surveyed and treated for a minimum of three years after the last hydrilla detection, followed by a minimum of another three years of intensive survey in order to declare that hydrilla has been eradicated from the site. Therefore, the CDFA considers hydrilla eradicated from a site only after a minimum of six years of negative detection. Longer periods of negative detection may be warranted, depending upon the site circumstances (see Best Management Practices, Appendix I).

In addition to surveying and treating for hydrilla, the Hydrilla Eradication Program monitors aquatic herbicide concentrations in water in order to confirm that the beneficial use of the state's waters are protected. This monitoring is done as a CDFA policy, and also to comply with the National Pollution Discharge Elimination System (NPDES) General Permit issued by the State Water Resources Control Board. The NPDES is a provision of the Clean Water Act to regulate and protect "waters of the United States" from pollution caused by point sources. This system was extended to aquatic pesticide applications by the United States Court of Appeals for the Ninth Circuit in its decision in *Headwaters, Inc. et al. v Talent Irrigation District*, March 12, 2001. To comply with the NPDES General Permit, the Hydrilla Eradication Program monitors fluridone water concentrations in Clear Lake and in the Riverview Golf Course ponds in Shasta County, and monitors for copper water concentrations in Clear Lake and in Bear Creek in Calaveras County. The Hydrilla Eradication Program also does monitoring upon request from the public in regards to the beneficial use of treated water. This report includes the results of the monitoring in response to requests from the public. The monitoring done in support of the NPDES General Permit will be published in a separate report.

The status of all current and historical sites in the Hydrilla Eradication Program is summarized in Plate 1 and Table 1.

Plate 1. Current Hydrilla Projects in California in 2004.

Table 1. Status of Hydrilla in California, by County, 1977 – 2004.

COUNTY	YEAR*	DESCRIPTION OF WATERWAY	SIZE	STATUS**
Calaveras	1988	Bear Creek, Units 2 to 11	5 miles	Survey
	1988	Stock Pond	0.5 acres	Active
	1996	Bear Creek, Unit 1	0.75 miles	Active
Imperial	1977	Imperial Irrigation System	270 acres, 600 miles of canals drains	Survey Active
Lake	1994	Clear Lake	1,440/43,000 acres	Active
Los Angeles	1980	Eight ponds	2 acres	Eradicated
	1983	One pond	<1 acre	Eradicated
	1985	One pond	<1acre	Eradicated
	2004	One pond	<0.5 acre	Survey
Madera/ Mariposa	1989	Eastman Lake /Chowchilla River	1,800 acres and 26 miles of river	Active
Monterey	1978	Pond	0.01 acre	Eradicated
Nevada	2004	One pond	0.6 acres	Active
Riverside	1977	One pond	<1 acre	Eradicated
	1984	One pond	<1 acre	Eradicated
	1985	Three ponds	<1 acre	Eradicated
San Bernardino	1988	One pond	<0.01 acre	Eradicated
San Francisco	1988	One pond	2 acres	Eradicated
San Diego	1977	Lake Murray	160 acres	Eradicated
	1977	One pond	<1 acre	Eradicated
Santa Barbara	1977	One pond	0.12 acre	Eradicated
	1993	One pond	<0.01 acre	Eradicated
Shasta	1985	Seven ponds	133 acres	Eradicated
	1986	Four ponds	23.5 acres	Eradicated
	1994	Two ponds	13 acres	Eradicated in 2004
	1996	Four ponds	39 acres	Active
Sonoma	1984	Spring Lake	72 acres	Eradicated
Sutter	1985	One pond	<0.01 acre	Eradicated
Tulare	1993	Three ponds	0.6 acre	Eradicated
	1996	Seven ponds	20 acres	Active
Yuba	1976	Lake Ellis	30.8 acres	Eradicated
	1990	One pond	6 acres	Eradicated
	1997	13 ponds	20 acres	Active
	1997	Canal	3 miles	Active

*Year first detected at a given site.

**Eradicated = No hydrilla found at site in six or more years of intensive survey following the last treatment.
Survey = No hydrilla found at site in last three to six years, intensive surveys continue.
Active = Hydrilla detected within the last three years, an active treatment project continues.

ACTIVE, ON-GOING SURVEY AND ERADICATION PROJECTS IN DETAIL

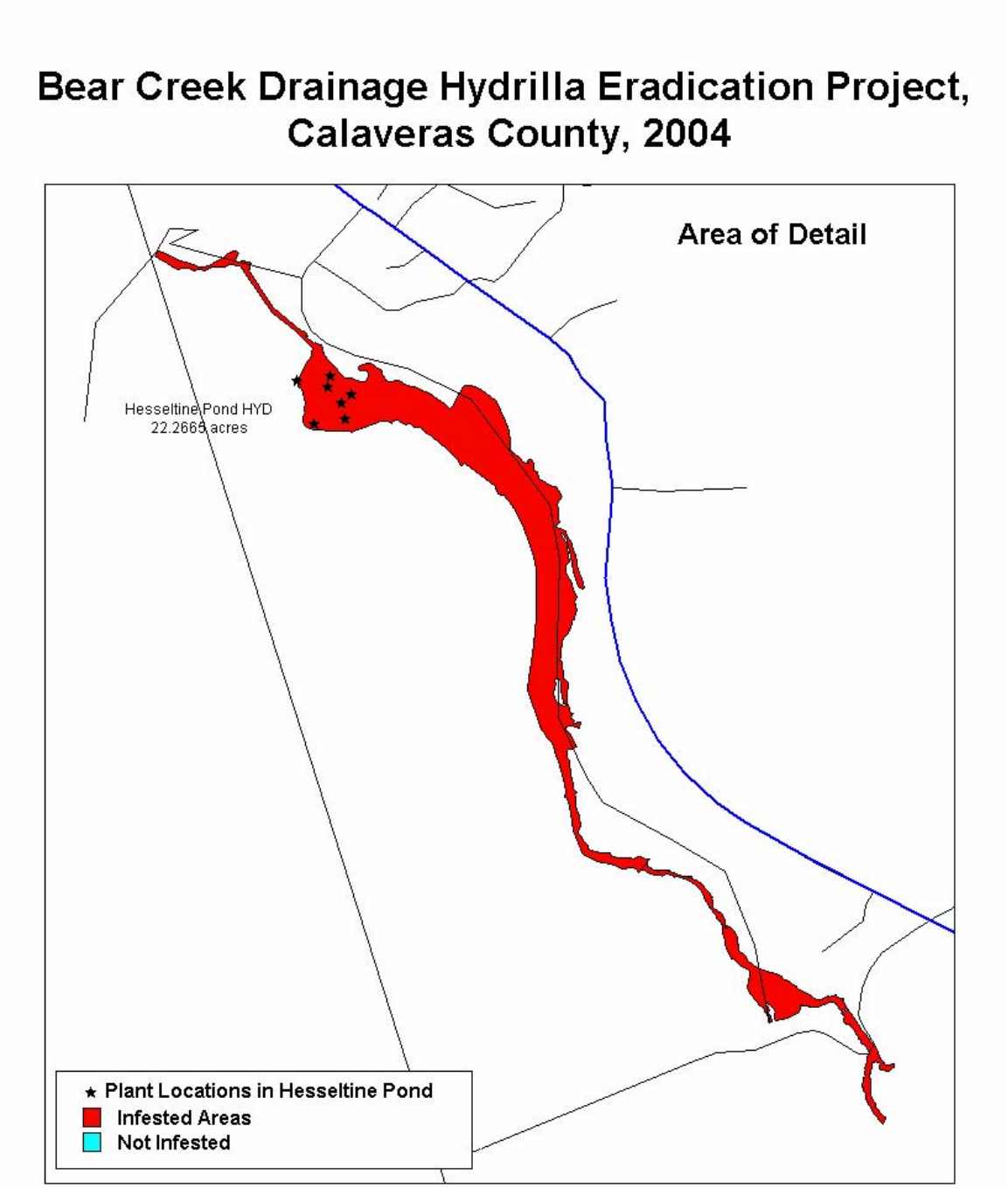
ALAMEDA COUNTY

On November 13, 2004, a CDFA biologist buying some aquatic organisms on his own time noticed what appeared to be hydrilla at a wholesale aquatic nursery in Alameda County. The hydrilla was in small plastic bags containing freshwater shrimp from Singapore for resale in California. The hydrilla was apparently being used to give the shrimp substrate to cling to, and perhaps to provide oxygen. The CDFA biologist delivered a plant sample to the CDFA Botany Laboratory where it was confirmed as hydrilla. The CDFA Pest Exclusion Branch was notified on November 19, and the Alameda County Department of Agriculture was notified shortly thereafter. An Alameda County Department of Agriculture biologist surveyed the nursery's entire freshwater supply of fish and shrimp and detected fragments of hydrilla in tanks containing freshwater shrimp from Florida (plant fragments were sent to the CDFA Botany Laboratory, which confirmed hydrilla). Contaminated tanks were subsequently screened and cleaned per CDFA protocols. On December 6, the Alameda County Department of Agriculture found that a second shipment of shrimp from Singapore was contaminated with fragments of hydrilla. Since then, all incoming shipments of freshwater shrimp, regardless of origin, have been treated as quarantined shipments under a "hold for inspection" status. The CDFA Pest Exclusion Branch has been in contact with the Florida shipper to address this problem at the source. Although Singapore shipments to the receiver have been discontinued, the Alameda County Department of Agriculture will continue to monitor all shipments of freshwater shrimp.

CALAVERAS COUNTY

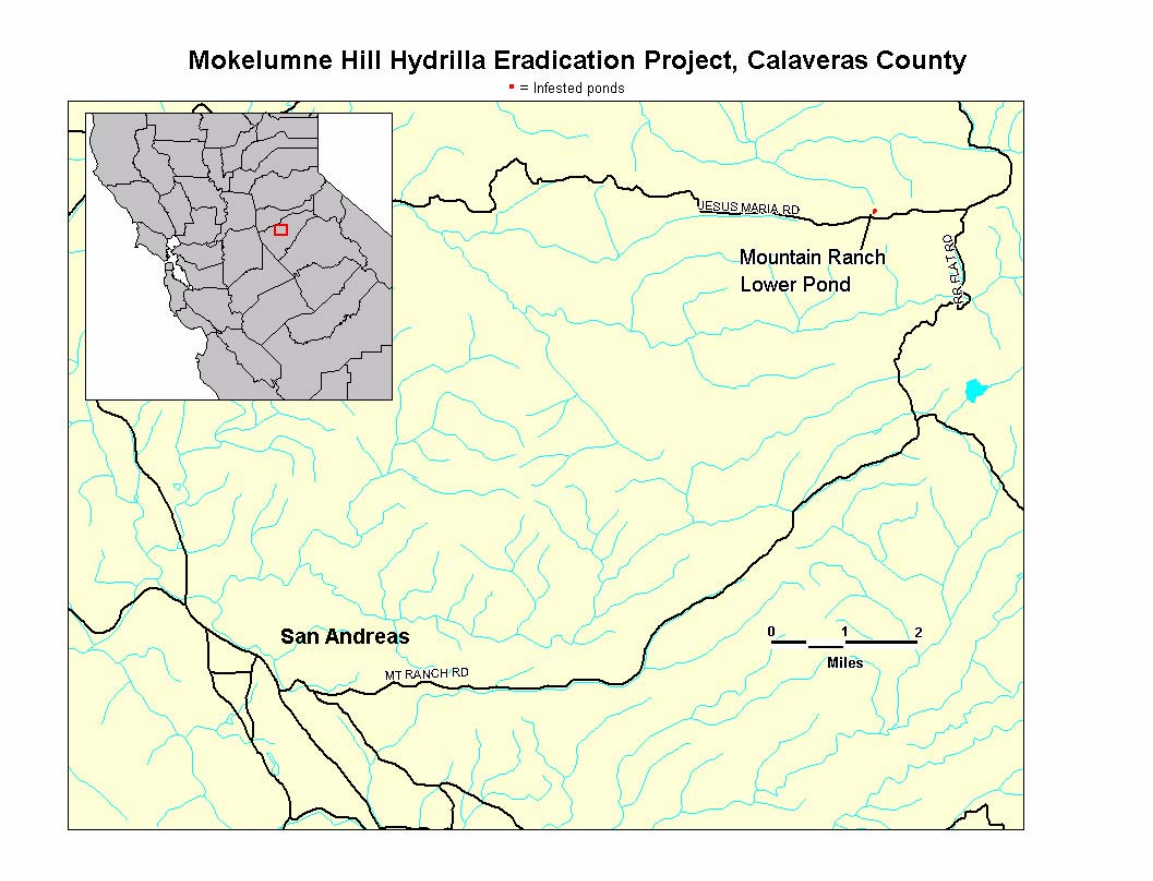
It is believed that there have been two separate infestations of dioecious hydrilla in Calaveras County, based on their geographic and hydrologic separation. The first infestation was detected in May 1988, consisting of ponded areas in Bear Creek and three isolated ponds between the towns of Burson and Wallace (Plate 2). The Calaveras County Hydrilla Eradication Project (Calaveras Project), a cooperative effort between the CDFA and the Calaveras County Department of Agriculture, began soon thereafter. The CDFA convened a Scientific Advisory Panel that made recommendations as to the survey, treatment, and public education in the Calaveras County area (Stocker. R.K. and L.W.J. Anderson *et al.* 1988). The Bear Creek drainage infestations are of particular concern because Bear Creek enters the Sacramento/San Joaquin River Delta at Disappointment Slough in San Joaquin County, only about 26 miles downstream from the lowest infested area on the creek (the Hesseltine ponded area).

Plate 2. Map of Hydrilla Infested Area of Bear Creek, Calaveras County.



Later in 1988, the CDFA and Calaveras County survey crews discovered a separate infestation, two ponds located near Mokelumne Hill (Plate 3). The two Mokelumne Hill ponds are located about 30 miles from the Bear Creek area and are 0.45 acres and 0.15 acres in size and are used for watering cattle. Another six cattle watering ponds surround them. The Mokelumne Hill infestation has been particularly troublesome because it has been difficult to eliminate the tuber bank. No hydrilla plants have been found in the smaller of the previously infested pond since 1998, but plants were detected in the larger pond in 2002, 2003 and 2004.

Plate 3. Map of Hydrilla Infested Stock Pond Near Mokelumne Hill.



Survey of the Bear Creek Drainage

In order to facilitate survey and treatment, project biologists divided the Bear Creek drainage into eleven management units. Due to the Calaveras Project's efforts, most of the originally infested ponds and ponded areas in the Bear Creek drainage project are approaching eradication and may be removed from the quarantine zone in 2005. Calaveras Project crews have not detected any hydrilla plants in management units six through 11 of Bear Creek since 1996 (Plate 2). They have not detected any hydrilla plants in units three through five (the Perock and Baker ponded areas) since 1998. In addition, no hydrilla has been detected in unit two since July 1999. In 2004, units two

through four were surveyed two to four times. No surveys were done in units six through 11, as these were dry for most of the summer.

In contrast to the above management units approaching eradication, the Hesseltine ponded area (unit 1) is still active because of recent hydrilla detections. Unit 1 is an approximate 10-acre pond located approximately one-half mile downstream from unit two. In 2004, project survey crews conducted six surveys of unit 1 and detected two hydrilla plants in unit 1, near a previously infested area of the pond (Table 2, Plate 2). One removed plant had a tuber attached, the other a turion. In 2004, the first survey was conducted on May 3; the water temperature was 28 degrees C (82 degrees F). The last survey was conducted on November 9; the water temperature was 14 degrees C (58 degrees F). Other aquatic vegetation detected in the Hesseltine ponded area included coontail (*Ceratophyllum* species), elodea (*Elodea canadensis*), mosquitofern (*Azolla* species), various pondweeds, watermeal (*Wolffia* species), water primrose (*Ludwigia* species), and cattails (*Typha* species).

Table 2. Number of Hydrilla Plants and Tubers Found and Removed from Bear Creek, Calaveras County, 2000 - 2004

Unit 1 – Hesseltine Ponded Area					
YEAR	**2000**	**2001**	**2002**	**2003**	**2004**
Mats	0	0	5	0	0
Plants	0	10	18	3	2
Tubers	-	46*	69*	-	2**

* Most tubers were recovered by dredging operations.
** One plant from tuber, one plant from turion.

Treatment of the Infested Management Unit in the Bear Creek Drainage

Since the first hydrilla find in unit 1 in 1996, Calaveras Project personnel have treated all infested areas in this drainage with various combinations of physical removal and applications of copper ethylenediamine and/or fluridone herbicide. In 2004, project crews found and removed two plants by hand, carefully removing as much of the plant and root crown as possible. One plant was found and removed on May 4 and the second on September 14. Areas immediately surrounding locations where plants have been detected in the last three years were treated with fluridone herbicide. A combination of the slow release pellet formulation and the liquid formulation was used, to provide more rapid and long-term control. There were four applications of the slow release pellet between May 12 and August 17, and three applications of the liquid formulation between June 17 and October 25. The cumulative total application in any given area was 90 ppb. In total, 6.9 pounds of fluridone active ingredient were used in the Hesseltine ponded area, management unit 1, in 2004.

Survey and Treatment of Mokelumne Hill

Calaveras Project survey crews surveyed the infested pond six times in 2004, and each of the near-by ponds two to six times (Plate 3). The first survey was on May 6, when the water temperature was 22 degrees C (72 degrees F). The last survey was on November 17, when the water temperature was 13 degrees C (55 degrees F). In total,

10 hydrilla plants were detected in the infested pond, pond three (Table 3). Unlike the 2002 finds, which were mats of hydrilla, the 2004 detections were single plants, and were detected and removed before growing to the surface and branching out. Other aquatic vegetation detected in these ponds included chara (*Chara* species), watershield (*Brasenia schreberi*), coontail, water primrose, American and curly leaf pondweed (*Potamogeton* species), and algae.

Table 3. Number of Hydrilla Plants and Tubers Found and Removed from the Stock Pond Near Mokelumne Hill, Calaveras County 2000 - 2004

YEAR	2000	2001	2002	2003	2004
Mats	0	0	4	0	0
Plants	0	0	1	22	10
Tubers	0	0	49	2	24

Project treatment crews hand removed all plants when detected, carefully removing as much plant material, including root crowns, as possible. The infested pond was treated three times with fluridone liquid formulation at 30 ppb between June 3 and October 13 for a total cumulative rate of 90 ppb. In total, one pound of fluridone active ingredient was used to treat this pond.

Surveys Outside of the Quarantine Zone

Calaveras Project personnel surveyed the following waterways in the vicinity of the Bear Creek infested ponded area in 2004: New Hogan Lake, Lake Amador, a private pond near the town of Valley Springs, and Bear Creek from the Calaveras-San Joaquin County line west, including all access points from the county line to Thornton Road in Stockton, approximately 26 miles. No hydrilla was detected.

Public Information and Awareness

In 2004, project biologists attended several meetings during which the project was discussed. Brochures were also distributed at the Calaveras County Agricultural Commissioner's Office.

IMPERIAL COUNTY

Imperial Irrigation District (IID) personnel first detected dioecious hydrilla in Imperial County in June 1977 in the All American Canal. The IID is a gravity-fed irrigation system that delivers water from the Colorado River via the All American Canal through a network of lateral canals, ponds, and other reservoirs to farmers' ditches, which in turn water the farms of the Imperial Valley. Drainage canals (drains) then carry the runoff and seepage to the New and Alamo rivers. IID personnel conducted surveys in 1988 and found that the hydrilla infestation covered, to a greater or lesser degree of plant density, 320 canals extending approximately 600 miles, 32 ponds comprising 161 surface acres, and 79 privately owned delivery ditches (farmers' sides).

The CDFA, IID, United States Department of Agriculture-Animal and Plant Health Inspection Service, California Department of Fish and Game (CDFG), and Imperial

County Department of Agriculture formed a cooperative agreement in 1981 to research and develop control and eradication methods for the IID. Between 1981 and 1984, the main control methods were mechanical removal of plant mats and mechanical dredging. In 1984, the IID received permission from the CDFG to stock the west side of the IID (the infested area) with triploid grass carp (*Ctenopharyngodon idella*) (TGC)[20]; the TGC has been the main control and eradication method since, supplemented by hand removal of individual plants, sealing of cracks in the canals with epoxy to prevent hydrilla emergence, and mechanical dredging when necessary. The IID stocks the TGC on a yearly basis at a target rate of up to 100 fish per mile for canals infested with aquatic vegetation, and up to 100 fish per acre for ponds infested with aquatic vegetation.

Survey and Treatment of the Imperial Irrigation District Canals and Associated Waterways

In 2004, IID weed control crews surveyed all canals, ponds, drains, and farmers' sides in the system for hydrilla and other aquatic vegetation. IID crews detected hydrilla in only one location, the Wildcat Drain (where hydrilla was also detected in 2002 and 2003, Plate 4). This compares to five infested sites in 2002 and two in 2003 (Table 4).

[20] The biological control agent, the triploid grass carp (*Ctenopharyngodon idella*) (TGC) is used to consume hydrilla and other aquatic vegetation. When used in confined areas, and at adequate stocking rates, the TGC can suppress a population nearly to extinction. However, to prevent establishment of a wild population, the CDFG Code requires that only sterile fish be stocked (TGC roe is put through a high-pressure treatment that gives each egg a triploid chromosome complement and makes the fish sterile). Nonetheless, the CDFG is concerned that the sterility might not be absolute, so they have tight restrictions on TGC use. According to the CDFG Code, the TGC cannot be deployed in any open water bodies that empty into natural waters of the state (CDFG Code, Sections 6440 through 6460). Therefore, all use of the TGC must be in areas that are contained with gates and screens, which severely restricts TGC use. Despite this limitation, the use of the TGC can be very effective in ponds and canals where the inlets and outlets can be screened to contain the fish.

Plate 4. Map of Current Hydrilla Quarantine Zone in Imperial County (green) and Area Removed from Quarantine Zone in 2004 (red).

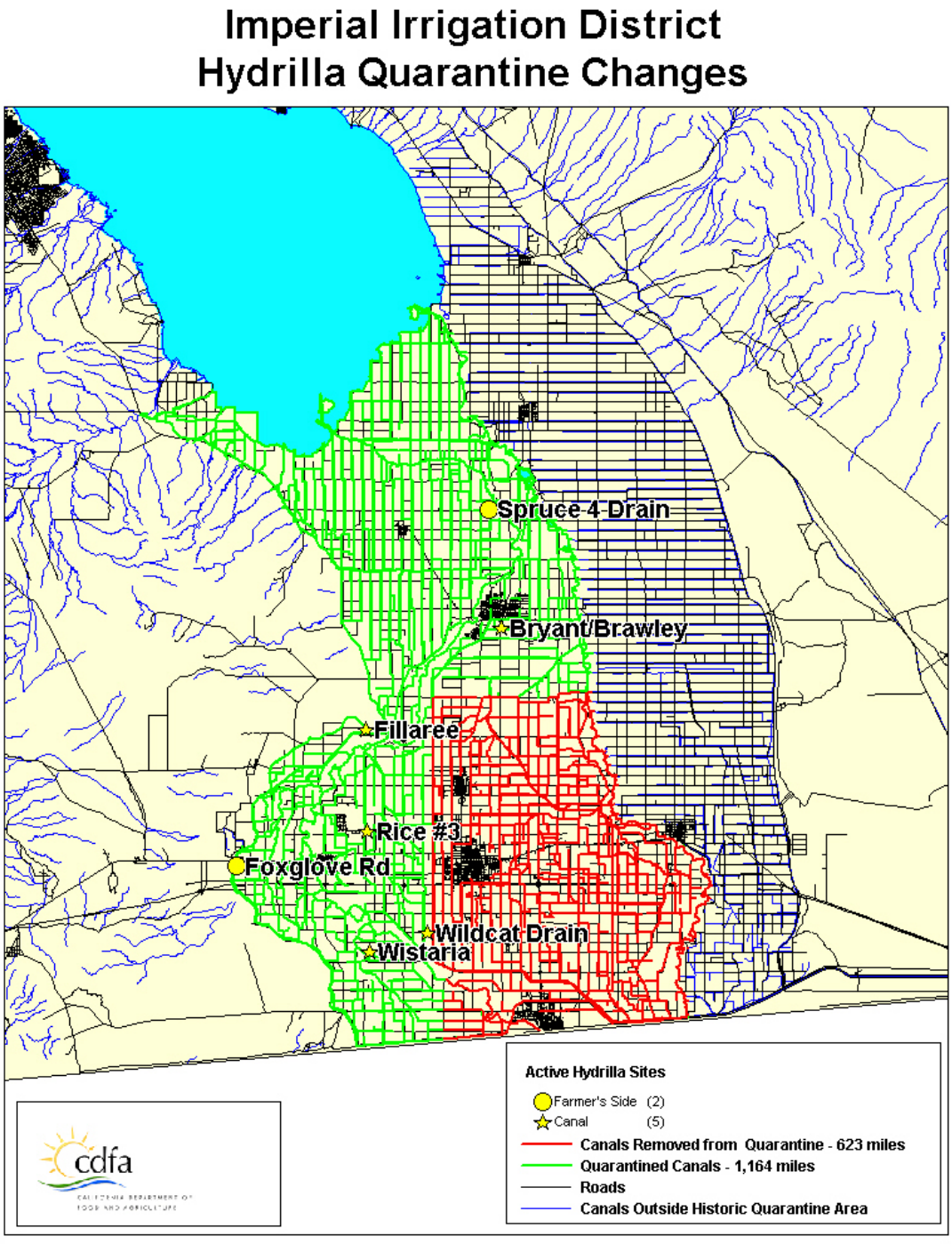


Table 4. The Number of Triploid Grass Carp Stocks and the Number of Hydrilla Infested Canals and Drains (and Farmers' Sides) in the Imperial Irrigation District, Imperial County 2000 – 2004

YEAR	2000	2001	2002	2003	2004
Number of TGC Stocked	2,432	2,841	2,101	2,822	1,129
Number of Infested Canals	0	1	1	1	0
Number of Infested Drains and Farmer's Sides	3	3	4	1	1

For the reason that the Wildcat Drain has been the reoccurring infestation in the IID, IID, Imperial County and CDFA personnel conducted an extensive survey of the hydrilla infestation in this drain in 2004. The week of November 26, IID, Imperial County Department of Agriculture and CDFA biologists and environmental scientists surveyed the entire length of the drain for hydrilla and mapped the infestation with Global Positioning System (GPS)/Geographic Information System (GIS) technology (Plate 4). The survey was conducted by foot and truck. The sole purpose of the Wildcat Drain is to transport excess subsurface water from farmers' fields, after irrigation. The Wildcat Drain is a little over five miles long, approximately five to 10 feet wide at the bottom, and drains into Rice Drain #3, which eventually drains into the New River. Just before entering the New River, the water flows through an experimental water treatment artificial wetland made up of small retaining ponds filled with cattails, operated by the IID, various government agencies, and Desert Unlimited, a private citizens group. CDFA and IID biologists divided the Wildcat Drain into 14 management sections, each 0.2 to 0.4 miles long (depending on the placement of culverts, turns, etc.), starting on the east end and proceeding west to Rice Drain #3. The first infested section is section two, where the hydrilla infestation is light. The heaviest infestation is in section nine, just east of the intersection of McCabe and Forrester roads. There is no hydrilla in the Wildcat Drain beyond section 11. CDFA and IID biologists will be implementing a plan to eradicate this last location of hydrilla infestation in Imperial County in 2005.

Because the east side of the IID was never heavily infested with hydrilla, and because no hydrilla has been detected there in over 10 years, this area was removed from the quarantine zone in 2004 (Plate 4). This area is roughly south of Keystone Road, east of Austin Road, west of the Alamo River, and north of the international border[21]. This reduced the infested area by one-third. This was a joint effort of the Imperial County Department of Agriculture and the CDFA Permits and Regulations Program, Pest Exclusion Branch, and Hydrilla Eradication Program, and was completed on November 30.

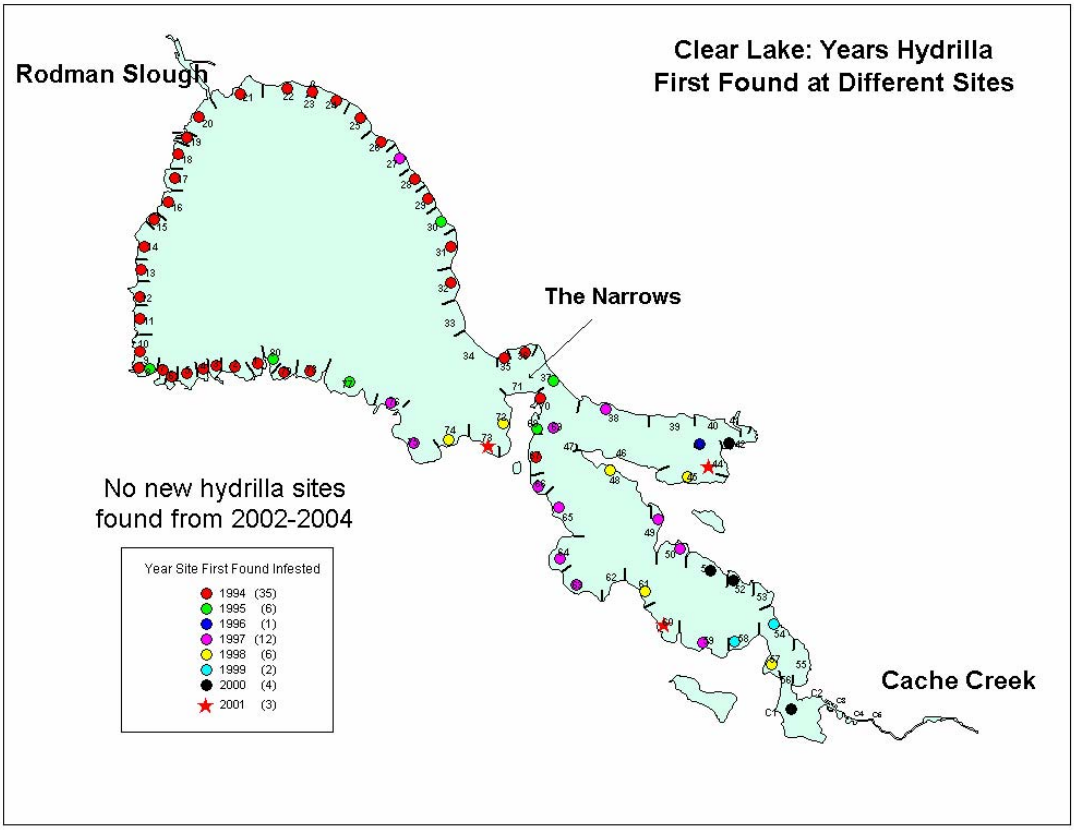
In 2004, Imperial County project biologists manually removed the hydrilla plants from the Wildcat Drain, where possible. The IID continues to employ the TGC for control of hydrilla and other aquatic vegetation in the canals (delivery system), but not in drains or farmers' sides. In 2004, the IID released 1,129 TGCs into canals and waterways remaining in the quarantine zone (Table 4)[22].

[21] For a complete description of the new quarantine zone boundaries, see the CDFA Plant Quarantine Manual, State Hydrilla Interior Quarantine, Section 3410.
[22] The IID also provided TGC to the Mexicali Irrigation District for aquatic weed control.

LAKE COUNTY

The Clear Lake Project is a cooperative effort of the CDFA, the Lake County Department of Agriculture, and the Lake County Department of Public Works. Clear Lake is the largest freshwater, natural lake completely within California's borders[23]. Clear Lake is almost 22 miles long and eight miles wide, has a surface acreage of approximately 43,000 acres, and has approximately 100 miles of shoreline (Plate 5). Clear Lake is located approximately 90 miles north of San Francisco. The lake is relatively shallow, with an average depth of approximately 26 feet. Because it is relatively shallow, and has winds most afternoons, Clear Lake is not highly stratified, even in late summer. Water temperatures range from mid to high 30 degrees C (86 degrees F) in the summer to five to 10 degrees C (40 to 50 degrees F) in the winter. These temperatures are ideal for hydrilla germination and growth from mid May until mid October, especially the monoecious form that is found in Clear Lake.

Plate 5. Map of Clear Lake in Lake County Showing Location of Hydrilla Program Management Units and the Year Hydrilla First Detected in Each Unit.



[23] Clear Lake is a popular fishing and water sports recreational lake. Clear Lake has often been described as the "Bass Capital of the West." The Lake is host to a number of bass tournaments throughout the year. There are also catfish, crappie, hitch and bluegill in the lake. There is also carp bow hunting.

Hydrilla was first found in Clear Lake on August 1, 1994 during a routine detection survey conducted by personnel from the CDFA and the Lake County Department of Agriculture. The CDFA and Lake County biologists responded rapidly and applied copper aquatic herbicide to some infested areas within two weeks of the first detection. In addition, the CDFA, with the cooperation of the Lake County Agricultural Commissioner, put Lake County under quarantine[24]. The CDFA and Lake County biologists conducted the initial delimiting survey in 1994 and found that 175 to 200 surface acres along the shoreline of the upper arm of Clear Lake were infested. Infestation levels varied from a few scattered plants to dense populations. In addition, in both 1994 and 1995, thousands of hydrilla fragments were visible at some of the boat ramps at the upper end of the lake. The CDFA also convened a Scientific Advisory Panel in 1994 (Stocker, R.K. and L.W.J. Anderson *et al.* 1994), which recommended a survey, treatment, and public education program.

Clear Lake project personnel divided the lake's shoreline into 86 management units (originally 80) in order to better organize and track eradication efforts (Plate 5). These management units were based on landmarks for ease of identification; they are not equal in length. These management units also vary in width but are usually about 500 feet from shore toward the center of the lake. In 2003, all of these management units were surveyed and mapped using GPS/GIS technology to increase accuracy of herbicide treatments, and to better coordinate aquatic vegetation management activities with the Lake County Integrated Aquatic Vegetation Management Program[25].

Survey of Clear Lake

Surveys within Clear Lake constitute approximately 40 percent of the Clear Lake project's field activities. The program has the goal of at least one survey per unit per month during the active hydrilla-growing season. In 2004, project crews conducted 316 surveys of the management units for an average of 3.7 surveys per unit. This is a decrease in the number of surveys compared to previous years, but the thoroughness of the surveys has increased. Surveys are now scheduled so that each treated unit is surveyed just before herbicide application to provide maximum opportunity for any hydrilla plants to grow and be detected.

No hydrilla plants were detected in 2004 (Table 5). The first survey in 2004 was on May 10 and the last on November 2. The water temperature at the time of the first survey was 19 degrees C (66 degrees F), and at the time of the last survey was 18 degrees C (64 degrees F). The number of plant finds has continued to decrease every year since the plant population has been low enough to count discrete finds (Plate 6, Table 5). The number of management units in which hydrilla was detected has also decreased from a maximum of 54 in 1998 to zero in 2004 (Table 5)[26]. Other aquatic vegetation detected in Clear Lake in 2004 included coontail (*Ceratophyllum*

[24] Because of the heavy recreational use of the lake, and the high risk that contaminated recreational equipment, clothing, or vehicles could spread hydrilla plant fragments, tubers, or turions around the lake, or out of the lake to nearby ponds, lakes, and streams (particularly Cache Creek), the CDFA and Lake County restricted movement of watercraft, motors, trailers, fishing gear, and other vehicles and equipment until they were inspected and cleaned of aquatic vegetation at the boat docks and ramps. These restrictions are still in place.

[25] The Clear Lake Integrated Aquatic Vegetation Management Program is a permit system to allow the public and Lake County to conduct weed control operations in Clear Lake. The program is operated by the Lake County Department of Public Works.

[26] This does not mean that hydrilla has been eradicated from the management units. It is very possible that new plants are emerging from tubers in the treated units, but that the fluridone herbicide treatments are suppressing their growth.

demersum), curlyleaf pondweed (*Potamageton crispus*), egeria (*Egeria densa*), elodea, Eurasian watermilfoil (*Myriophyllum spicatum*), American pondweed (*P. nodosus*), Illinois pondweed (*P. illinoensis*), sago pondweed (*Stuckenia filiformis*), smartweed (*Polygonum* species), water hyacinth (*Eichhornia crassipes*) and spatterdock (*Nuphar luteum*).

Plate 6. Map Showing Change in Hydrilla Infestation in Clear Lake from Year of First Detection, 1994, to Current Year, 2004.

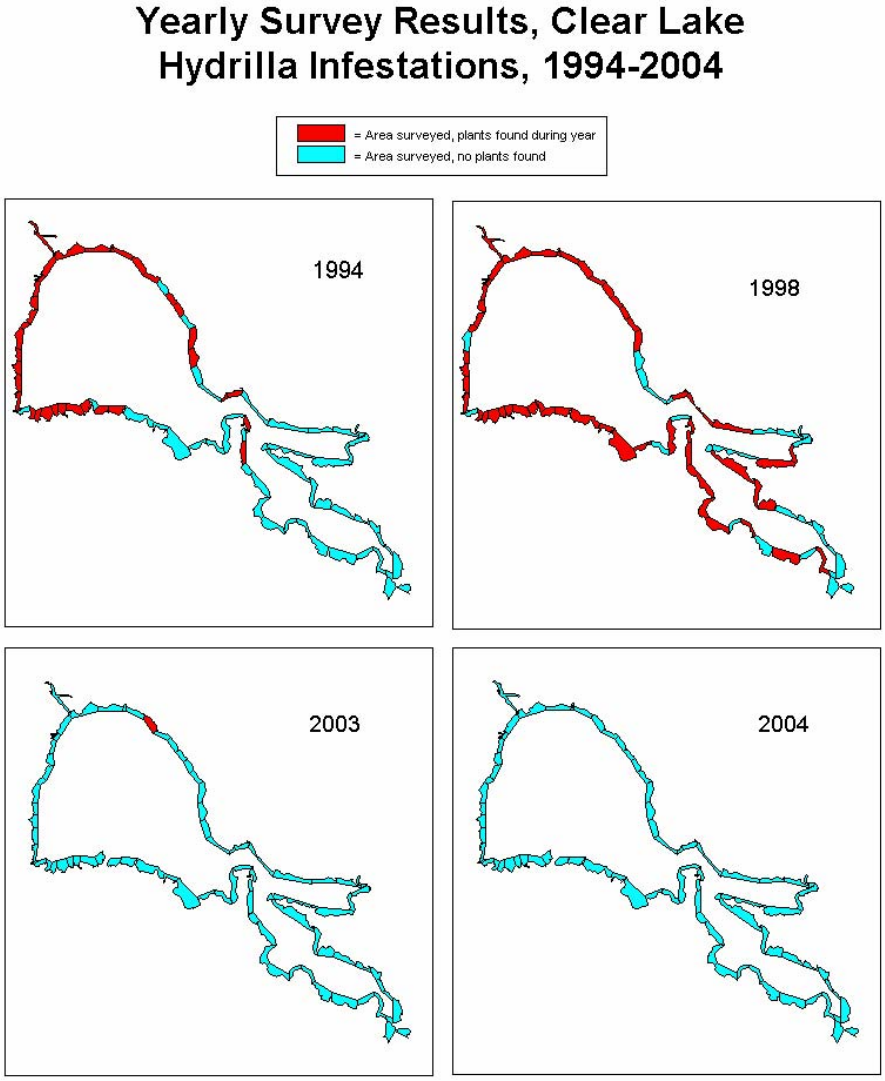


Table 5. Level of Hydrilla Infestation in Clear Lake, Lake County by Number of Infested Management Units* and Number of Finds 2000 - 2004.

YEAR	2000	2001	2002	2003	2004
Number of Management Units with "Finds"	31	21	6	1	0
Number of Hydrilla "Finds"	67	41	12	1	0

*The management units were originally defined in reference to natural boundaries in the landscape for ease of location, survey, and treatment. The management units are not identical in terms of size or shape.

Clear Lake project crews survey the center sections of the lake in mid to late summer every year. Mid to late summer was chosen because if any hydrilla plants were growing in the deeper water sections of the lake, they would have reached near the water surface by this time, and be fairly easy to detect. In 2003, project crews made 31 center section surveys, an increase over previous years. No hydrilla has ever been detected in deep-water sections of the lake.

For aquatic weed management in Clear Lake, other than that conducted by the CDFA, the Lake County Department of Public Works has an on-going program in which the county contracts with private applicators to control aquatic weeds at county public use areas. These permits require the applicant to identify the location of all proposed treatments, the method of treatment, and any aquatic vegetation present. The CDFA Agricultural Pest Control Supervisor at Clear Lake reviews these permits before treatment can commence to assure proposed activities taking place in permitted areas does not negatively impact CDFA's hydrilla eradication efforts. In 2004, there were 140 permits. None of these permittees have ever reported the presence of hydrilla in the lake.

In addition to surveys, the Clear Lake hydrilla crew also does boat and trailer inspections for hydrilla before and after major fishing and boating events. In 2004, they conducted 80 boat inspections and 100 trailer inspections. This is an increase in inspections over previous years. No hydrilla was found.

It is important to note that Hydrilla Eradication Program managers do not assume that zero hydrilla detections in Clear Lake in 2004 imply that the lake is free of hydrilla plants or plant fragments. CDFA surveys are very thorough, but no survey system, no matter how intense, can detect small plants or plant fragments growing in the entire lake amongst the mass of aquatic weeds that undergo rapid, active growth in the spring and summer. Program managers acknowledge that large mats of hydrilla would be detected with near 100 percent effectiveness, but that small individual plants could escape detection. In addition, program personnel continue to treat large areas of the lake with fluridone slow release pellets. The intended purpose of this herbicide is to eradicate hydrilla plantlets emerging from underground tubers. If successful, this herbicide would control small plants before they are detected. Program managers suspect that there are still a significant number of tubers in the hydrosoil in Clear Lake, and that these tubers could continue to germinate for another five to ten years.

Treatments of Clear Lake

In 2004, the CDFA used fluridone aquatic herbicide as the eradication method of choice in Clear Lake[27]. For the reason that no hydrilla plants were detected, no copper aquatic herbicide[28] (Table 6) or small-scale dredging or other eradication methods were used. However, these methods may be used in the future if new hydrilla plants are detected.

Table 6. Aquatic Herbicide Used by the CDFA in Clear Lake, Lake County 2000 - 2004.

ACTIVE INGREDIENT	Copper					Fluridone				
YEAR	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Treated-Acres*	117	62	28	5	0	1,149	1,335	1,440	1,256	520

*Some sites were treated multiple times, but data is expressed as "treated-acres," i.e. one-acre treated multiple times is one treated-acre.

The Clear Lake project's use of fluridone has decreased in the last two years as a result of a decrease in plant detections (Table 5). In 2004, project treatment crews applied the first fluridone slow release pellets on May 11, and the last on July 28. In 2004, 520 acres were treated with fluridone slow release pellets, a 64 percent reduction from 2002, the year of maximum treatment. The highest cumulative application rate used in 2004 was 120 ppb because there were no new infestations detected this year (see footnote 30 for the program's treatment schedule). A total of 867 pounds of fluridone active ingredient were applied to Clear Lake in 2004. Visual observations and surveys indicated that the fluridone slow release pellets gave complete control of hydrilla in treated areas.

Starting in 2000, some management units have been hydrilla free for over three years and are no longer actively treated; however, surveys continue. In 2004, there were 79 units that were previously infested, but are now apparently hydrilla free, and are no longer treated, though surveys continue[29].

[27] Fluridone slow release pellets have the advantage that they give residual control because they release the active ingredient slowly into the water system. In addition, fluridone slow release pellets are easy to apply and their use concentrates the fluridone near the hydrosoil where it controls plants emerging from newly germinated tubers. In general, the Clear Lake project treatment crews apply fluridone slow release pellets on a two-week schedule, once applications begin in the spring. The treatment zone is a five-acre area around the location of each plant find that has occurred in the previous three years. The standard treatment is seven applications at 20 ppb (calculated to a maximum depth of six feet only) applied on a two-week schedule for a yearly maximum of 140 ppb. The number of applications is decreased to six (120 ppb yearly maximum) in management units in which hydrilla has not been detected the previous year. The number of applications are further decreased to five (100 ppb yearly maximum) in management units in which hydrilla has not been detected in the previous two years (Plate 5). After hydrilla has not been detected for the previous three years, herbicide treatments to that unit cease, but intensive survey continues.

[28] This herbicide is applied on an as-needed basis to achieve rapid destruction of biomass in areas where plants or plant fragments are found. A five-acre area around each plant find is treated with copper ethylenediamine herbicide at one-ppm copper within a few days of any find. Copper ethylenediamine, because it is a contact herbicide, is still the herbicide of choice for rapid dissolution of large plants and mats, and in certain other situations, such as where water might be used for irrigation or where it is not practical to obtain the long contact time required by fluridone.

[29] The CDFA Hydrilla Eradication Program prohibits the use of mechanical harvesters in areas in which hydrilla has been detected in the previous six years. The prohibited area is a circle of a one-quarter mile radius around each find. The reason for this prohibition is that even the best mechanical harvesters leave numerous plant fragments that could potentially become established thereby spreading the hydrilla infestation.

Surveys Outside of the Quarantine Zone

As the time and resources required for making herbicide applications have decreased in Clear Lake, the Clear Lake project crews are able to dedicate more time to surveying surrounding lakes, ponds, streams and other water bodies in order to detect any hydrilla infestations in the incipient stage and prevent re-infestation of Clear Lake itself. These surveys are conducted because of the possibility that boats, trailers, or other equipment originating from Clear Lake might transport hydrilla fragments, tubers, or turions to these nearby lakes and reservoirs. In 2004, project crews surveyed numerous water bodies in the Clear Lake area including Indian Valley Reservoir, Highland Spring Reservoir, Lake Pillsbury, and Blue Lakes in Lake County. In addition, major reservoirs and lakes in Glenn, Napa, and Sonoma counties and Cache Creek in Yolo County were also surveyed (for a complete list of surveyed areas, see Appendix II). No hydrilla has been detected during these surveys, though aquatic weeds detected included coontail, sago pondweed, and water primrose.

Public Information and Awareness

Public information and awareness are essential components of the Clear Lake project. Recreational fishermen, guides and outfitters, fishing tournament organizers, sailors and boaters, and other recreational users of Clear Lake need to know how to prevent the spread of hydrilla in the lake and from Clear Lake to other lakes, streams, ponds and reservoirs in order to prevent infestation of these resources. Since public access to the lake is not restricted, and there are hundreds of access points, public education and awareness efforts must include both traditional and non-traditional outreach venues. This aspect of the Clear Lake project must be maintained.

In 2004, Clear Lake project personnel distributed Notices of Intent and informational pamphlets to all homeowners and businesses with lakefront property, prior to initiation of aquatic herbicide applications. In addition, Clear Lake project personnel distributed approximately 1,200 informational pamphlets to businesses and government agencies around Clear Lake. The Clear Lake project's aquatic herbicide treatment schedule was also posted on the Lake County Department of Public Works website[30].

In 2004, Clear Lake project personnel made seven presentations to the public about the project. The project was highlighted in a poster at the California Weed Science Society in January, and in a presentation at the Western Aquatic Plant Management Society conference in March, and in a presentation at the California Lake Management Society conference in June. In August, Clear Lake project biologists and Lake County biologists reviewed the Clear Lake hydrilla project and the Lake County Aquatic Vegetation Management Project for representatives from the United States Army Corps of Engineers and United States Environmental Protection Agency. In November, project biologists made a presentation at a meeting of the Lake County Board of Supervisors, which was broadcast on local television, and rebroadcast in whole or in part on television and radio several times thereafter. Later in the month, CDFA biologists made a presentation about the project at a meeting of the Hinthil Environmental Resources Consortium, an environmental group consisting of the major Native American tribes in

[30] http://watershed.co.lake.ca.us

Lake County[31]. In addition, several informal discussions of the project occurred at other events during the year.

LOS ANGELES COUNTY

On March 5, 2004, two biologists, one from the CDFA Pest Exclusion Branch and the second from the Los Angeles County Department of Agriculture, during a routine inspection, detected what appeared to be hydrilla in an aquatic plant nursery near Reseda, California. Plant samples were sent to the CDFA Botany Laboratory where they were positively identified as hydrilla. A thorough inspection of the site showed that the hydrilla infestation was confined to two tubs of water lilies and a pond 60 feet long by six feet wide by 18 inches deep, also containing water lilies. The water level in the pond was 12 inches and the pond was plastic lined. The nursery owner said he believed that he received the hydrilla as contaminate in a shipment of water lilies he had received about a decade earlier. The Los Angeles County Department of Agriculture put a "hold" notice on the infested pond and tubs so that hydrilla or infested plants could not be removed from the premises.

The owner of the infested aquatic plant nursery provided project biologists with a list of all customers that had been shipped plants from the infested pond. There were nine customers total in Los Angeles, Orange, Ventura, and Santa Barbara counties. CDFA Pest Exclusion Branch biologists and County biologists inspected these sites and detected no hydrilla.

On May 3, CDFA Integrated Pest Control Branch and Pest Exclusion Branch biologists and Los Angeles County biologists drained and cleaned hydrilla from the infested pond and plants. Biologists began by gently raking the water surface to remove floating hydrilla strands, algae, and water lettuce from the pond. The nursery owner provided a small pump to lower the water level of the pond. The water was pumped through a screen to remove any hydrilla fragments or tubers that might be pumped out. By the end of the day, the water level had dropped to three inches and most of the floating plant material had been removed. On day two, the owner provided a second pump that pumped from the bottom and lowered the water level to one inch at which point it became difficult for the pump to work due to concentrated muck on the bottom. Project biologists then proceeded to sweep up the muck and remove it by the bucket load. On day three, project biologists finished sweeping the muck and residue from the bottom of the pond, which was then clean and there was no hydrilla.

The hydrilla, muck, and other debris were removed to an empty area in the nursery to dry out. All hydrilla tubers and turions were collected and inspected before being disposed of. A total of approximately 100 hydrilla tubers and turions, mostly turions, were removed from the pond and plants. Based on the size of the hydrilla leaflets, and the length, width, and size of the tubers, project biologists believe the hydrilla was of the dioecious form. Project biologists shipped tubers to the United States Department of Agriculture-Agricultural Research Service for further analysis.

The water lilies that were growing in the infested pond were then cleaned. Project biologists and nursery workers removed the water lilies from their pots and cleaned the

[31] This consortium is made of representatives from the six Pomo tribes of Native Americans that live near Clear Lake (Big Valley Rancheria, Elem Indian Colony, Habematolel Pomo of Upper Lake, Middletown Rancheria, Robinson Rancheria, and Scott's Valley Band of Pomo Indians).

pots and examined the plants and plant roots for hydrilla fragments or tubers, and removed any hydrilla fragments and tubers that were found. The water lilies were then repotted and replaced in the pond, which was refilled with clean water. The pond and plants remain under quarantine by the Los Angeles County Department of Agriculture, and are routinely inspected by their biologists. No hydrilla has been found since the pond and tubs were cleaned.

Project biologists will continue to survey the nursery through 2005. If no hydrilla is found, it will be considered eradicated.

MADERA AND MARIPOSA COUNTIES

In June 1989, CDFA and Madera County Department of Agriculture personnel, during a routine survey of aquatic sites in the county, detected dioecious hydrilla in Eastman Lake. Eastman Lake is a 1,800-acre reservoir that belongs to the United States Army Corps of Engineers and is used for flood control, irrigation, recreation and wildlife. The survey crews found scattered patches of hydrilla along the northern section of the lake and along the eastern and southeastern shoreline, amounting to 100 infested acres.

During an extensive survey of all known water bodies in the vicinity of Eastman Lake, survey crews detected hydrilla upstream of the lake in the west fork of the Chowchilla River. After a thorough survey, the crew determined that approximately 26 miles of the river were infested. Plant density ranged from sites with single plants to sites with dense patches.

The CDFA, Madera County Department of Agriculture, Mariposa County Department of Agriculture, and United States Army Corps of Engineers initiated the Madera and Mariposa Counties Hydrilla Eradication Project (Madera/Mariposa Project) in 1989, right after the first detections were made. The CDFA, with the cooperation of the Madera County Department of Agriculture and Mariposa County Department of Agriculture, and United States Army Corps of Engineers issued a quarantine for all of Eastman Lake and for the infested portions of the Chowchilla River. Both the lake and the river were then placed under quarantine and closed to recreational use. Survey crews have not detected hydrilla in Eastman Lake since 1993. As a result, quarantine restrictions have been progressively lifted so that today only the uppermost section near the inlet remains under quarantine, where fishing is prohibited. This final restriction may well be lifted in 2005. The west fork of the Chowchilla River remains under quarantine, and fishing is prohibited in all management units[32].

Survey of Eastman Lake

For the reason that hydrilla plants and tubers were detected upstream of Eastman Lake in the west fork of the Chowchilla River as recently as 2002, surveys of Eastman Lake continue, and will continue until the hydrilla is declared eradicated in the Chowchilla River. In 2004, crews surveyed Eastman Lake by boat and canoe four times. The first survey was on May 25, when the water temperature was 23 degrees C (74 degrees F). The last survey was on October 22, when the water temperature was 17 degrees C

[32] In 1989, project leaders divided the lake and river into 38 management units for tracking of survey and eradication activities. The units followed the original property lines and are not the same length or area.

(63 degrees F). Other aquatic vegetation detected included common elodea, coontail, southern naiad (*Najas guadalupensis*), chara, and algae.

Because of continuing drought in the area, the United States Army Corps of Engineers again reduced the water level of the lake to near minimum pool (466 foot elevation), exposing the sites of the original hydrilla finds to drying. No hydrilla was detected in the lake or at the exposed original sites. No herbicide treatments were made.

Survey and Treatment of the Chowchilla River

In 2004, project survey crews conducted between two and three surveys of each management unit along the river. The first survey was on May 21, when the water temperature in the river was 19 degrees C (67 degrees F). The last survey was on November 22, when the water temperature was 10 degrees C (49 degrees F). For the second year in a row, no hydrilla plants or tubers were detected in any of the 38 management units (Table 7). However, these results should be interpreted with caution. Drought continued in this area in 2004. The lack of water could be masking the hydrilla population by forcing the tubers to remain dormant in the dry soil and artificially reducing the survey counts. Alternatively, the tubers could be expiring in the dry soil. The effects of the drought, and the true hydrilla population, will not be known until wet years return. Other aquatic vegetation detected in the Chowchilla River included common waterweed, American pondweed, curly leaf pondweed, water primrose, coontail, duckweed (*Lemna* species), mosquitofern, chara, hairy pepperwort (*Marsilea vestita*), arrowhead (*Sagittaria* species), cattail, and algae.

Table 7. Number of Hydrilla Plants and Tubers Found and Removed from the Chowchilla River Project, Madera and Mariposa Counties 2000 – 2004.

YEAR	2000	2001	2002	2003	2004
Plants	19	5	2	0	0
Tubers	1,789	23	3	0	0

Though no hydrilla was detected in 2004, project crews treated the two areas where hydrilla was detected in 2001 and 2002. In 2001, hydrilla plants were found in Management Unit 2 near Raymond Bridge, and in 2002, plants were found upstream in Management Unit 29. Each area was treated once with fluridone slow release pellets for a total of 90 ppb each. Treatment dates were August 6 and September 28. A total of 0.25 pounds of fluridone active ingredient were used in 2004.

Surveys Outside of the Quarantine Zone

Project crews surveyed the following water bodies in the Eastman Lake and Chowchilla River area in 2004: Hensley Lake, Millerton Lake, Lake Yosemite, and along the Chowchilla River from Highway 49 overcrossing to Management Unit 38 (the most upstream end of the infested area). Lakes were surveyed by boat and/or canoe, and the river by foot. No hydrilla was detected.

NEVADA COUNTY

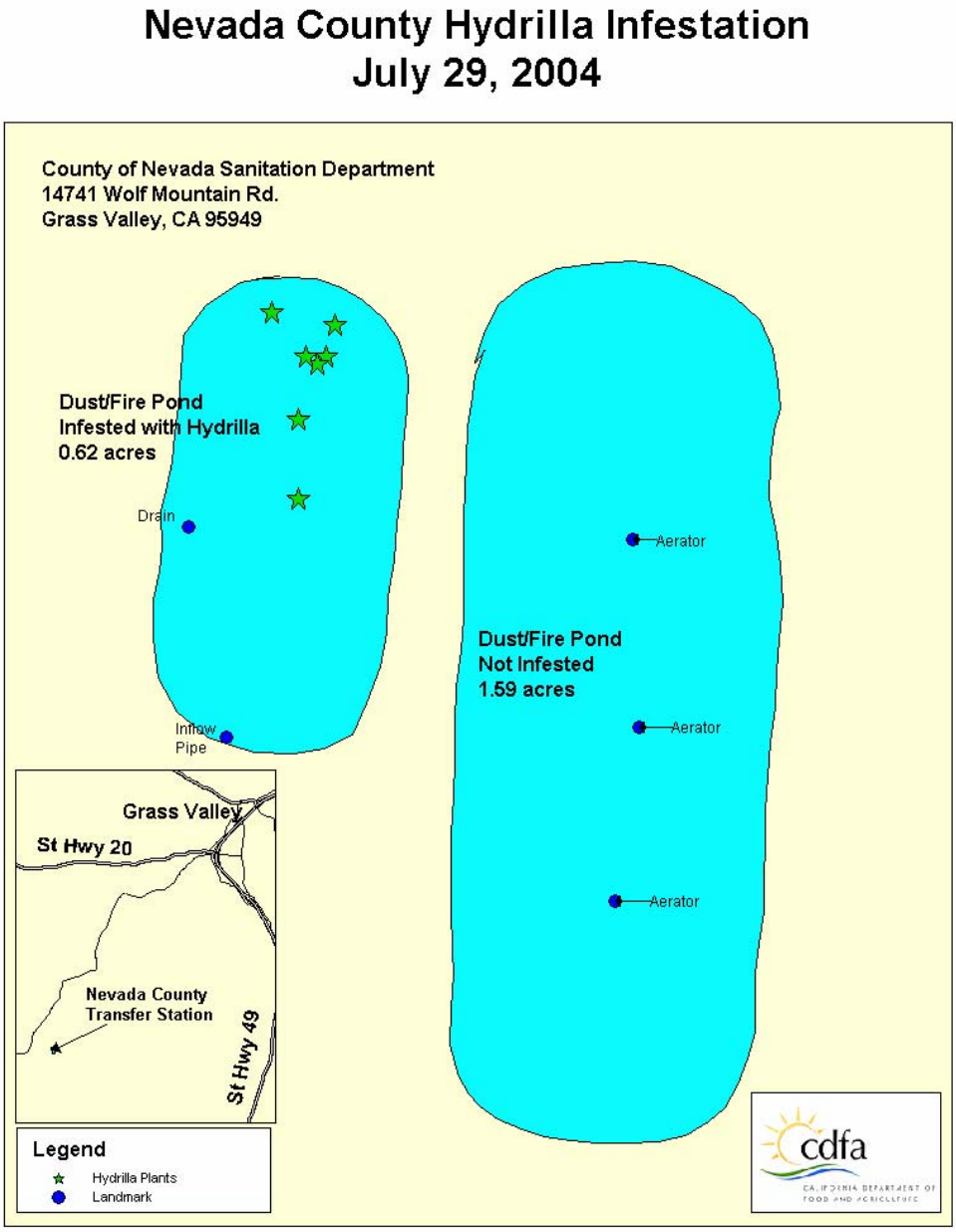
On July 21, 2004, a representative of an aquatic vegetation management company spotted what appeared to be hydrilla in a fire control pond at the Nevada County Transfer Facility near Grass Valley. He took a sample, submitted it to the CDFA, and it was positively identified by the CDFA Botany Laboratory as hydrilla soon thereafter. The CDFA and the Nevada County Department of Agriculture then started the Nevada County Hydrilla Project.

Project biologists worked with the CDFA Permits and Regulations Program to have Nevada County added to the hydrilla eradication area by the Office of Administrative Law on August 5. On August 18, the CDFA Environmental Officer performed the first of two surveys around the infested pond for threatened and endangered species, and determined that treating the infested pond with aquatic herbicides would not mount a threat to existing populations of threatened and endangered species. Shortly thereafter, the CDFA Primary State Biologist (vertebrate specialist) made a survey of the frog population in the infested pond and determined they were non-native bullfrogs. On August 23, the Secretary of Agriculture signed the Proclamation of Eradication Project.

Survey of the Fire Control Pond

Project biologists surveyed, mapped, and delimited the pond and infestation (Plate 7). Several hydrilla mats were clearly visible at the water surface in the northeastern third of the pond, including one that was fairly large (Plate 7). In total, the pond is 0.6 acres in area, 18 feet deep, and holds one million gallons of water. The pond was originally constructed to hold leachate from a legacy waste dump on site, but proved too small so a much larger pond was constructed nearby. A second layer of plastic lining was placed at the bottom of the pond, and it was turned into a fire control pond. It is used as a water source for fire emergencies and to cool a waste wood chipping operation on the site. Substantial amounts of water are pumped several times a month for the wood chipping operation. In addition to the fire control pond and the new leachate pond, the Nevada County Transfer Facility site is a "no-runoff" site, and is surrounded by a drainage canal and several ponds to capture runoff.

Plate 7. Map of Hydrilla Infested Pond (left) and Leachate Pond (right) at Nevada County Transfer Facility Near Grass Valley.



In early August, CDFA divers free-dived the pond at the northeast end where the hydrilla mats were most visible. Divers reported several inches of sediment at this end of the pond, and recovered several tubers in the sediment. CDFA biologists then pulled up one of the smaller mats by hand and rake, and the hydrilla was examined for tubers. Thirty-four tubers were recovered, indicating a fairly substantial tuber bank is probably present at this end of the pond.

Also on August 23, Dr. Lars Anderson of the United States Department of Agriculture-Agricultural Research Service did a pre-treatment survey of the density of the hydrilla infestation (see cover) and the water quality. Dr. Anderson determined that the water in the pond was not stratified (probably because of mixing due to constant breezes and the frequent pumping.) Dr. Anderson sampled five sites in the pond by placing a one quarter meter floating frame on the water and removing all the hydrilla from the water column with a long handled rake. Dr. Anderson also took underwater video of the infestation. In the samples, he found an average of 2.3 (+/- 0.7) kilograms of hydrilla dry matter per meter squared (Anderson, Lars W.J. 2004 Unpublished data, United States Department of Agriculture-Agricultural Research Service-Exotic and Invasive Weed Research Unit). In both the samples and the video, he found that most of the water column was filled with hydrilla, even where it was not clearly visible at the surface. Dr. Anderson commented that this was the highest tensile strength hydrilla he had ever encountered.

Treatment of the Fire Control Pond

On August 25 and 26, CDFA divers removed approximately 30 cubic feet of hydrilla by hand from the center bottom of the pond. Few tubers were found in this hydrilla, and little sediment was found on the pond liner in the center bottom of the pond, indicating that the tuber bank in this section of the pond may be fairly limited. Immediately afterward, the divers installed a guard around the intake at the bottom of the pond to protect it from becoming clogged with dying plant matter after an herbicide treatment. On August 26, CDFA biologists applied 0.4 pounds of copper herbicide to the large mat of hydrilla that had reached the water surface. Afterwards, they treated the entire pond with one pound of fluridone in the liquid formulation. On September 24, a second application of 1.6 pounds of copper herbicide was made.

On October 21, a visual assessment of the treatment efficacy and a water sample to measure the fluridone concentration was made. The large mat of hydrilla, which had been at the water surface, appeared to be about five feet below the surface, and roughly 10 percent of its former size. Several plant fragments near the pond banks showed leaf stripping typical of copper treatment and a pink coloration typical of fluridone treatment. The water sample was sent to SePRO Corporation for analysis by FasTEST, and was determined to contain 26.5 ppb fluridone. The local SePRO representative determined that this was adequate to continue to control the hydrilla.

On November 18, a second visual survey was conducted. No mats of hydrilla were visible at or below the water surface. A few fragments were found along the pond edges, which were white or pinkish in color, consistent with fluridone symptoms. In December a third visual survey was conducted; the water was murky, but no mats of hydrilla were visible. There were several floating strands of hydrilla, without leaflets, showing some pink discoloration.

Survey of Surrounding Area

On August 3, the Nevada County Agricultural Commissioner provided project biologists with an aerial map of the Grass Valley area, showing all the water bodies within a five-mile radius of the infested pond. Between August 3 and September 24, project biologists surveyed all the accessible ponds and waterways within a one-mile radius of

the infested pond. A large aquatic nursery near Grass Valley was also surveyed. No hydrilla was detected. The survey will continue in 2005.

Public Outreach and Education

On August 4 and 5, project biologists and the Deputy Agricultural Commissioner conducted training sessions on hydrilla for personnel of the National Resources Conservation Service, Resource Conservation District, the Nevada Irrigation District, and the Nevada County Transfer Facility. A local college professor and pond management specialist and a local feed store worker also attended. The feed store worker said aquatic plants were often brought in for him to identify. These professionals are responsible for responding to calls about weeds and other problems at water features at homes and businesses in the Nevada County area. In addition, they do some survey of waterways in the county. As such, they are in a prime position to be the first to detect hydrilla in adjacent water features or waterways.

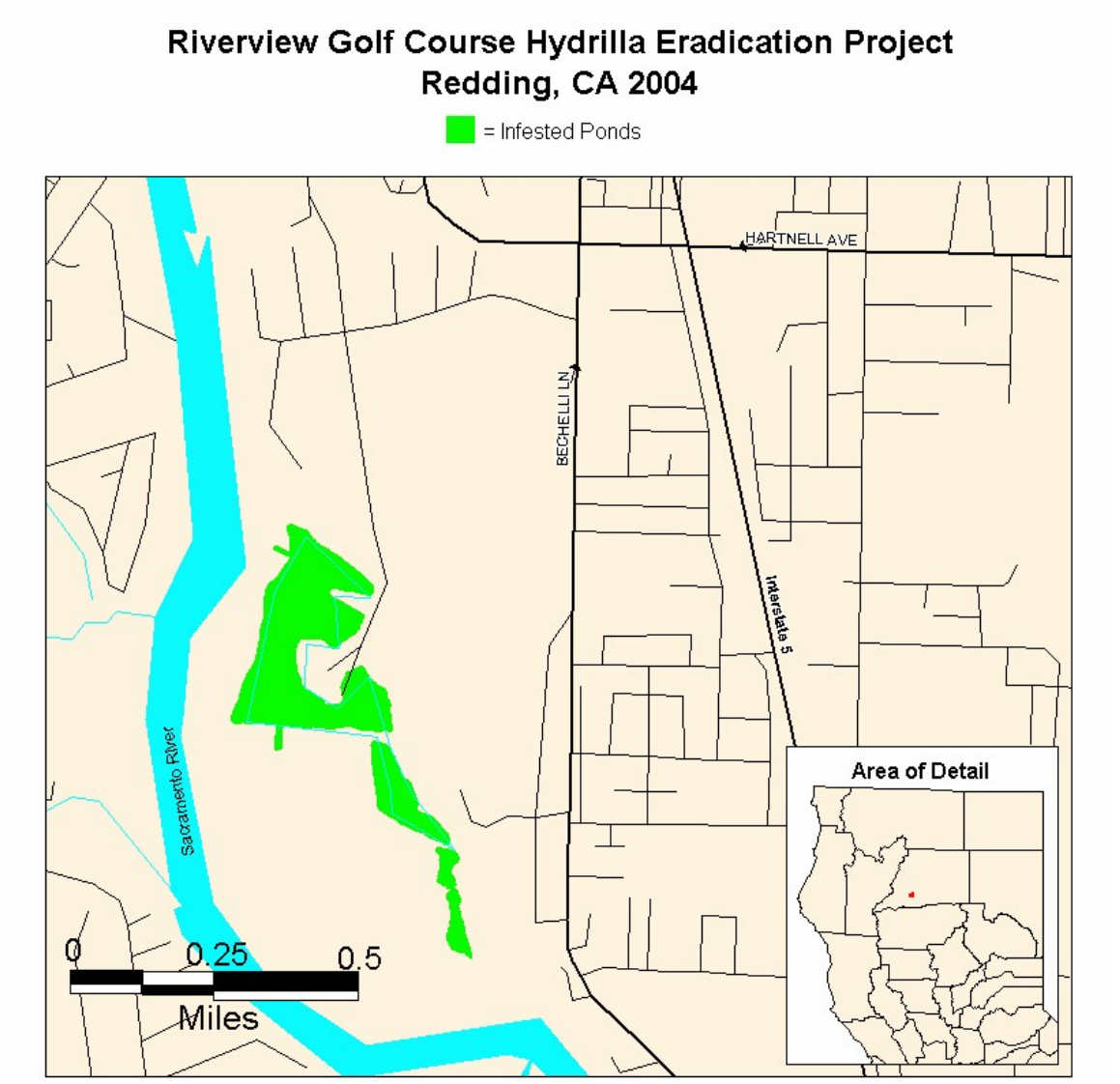
On August 19, project biologists gave a presentation on hydrilla to about 20 Sacramento Valley deputy agricultural commissioners in Grass Valley. The presentation was followed by a hands-on training in the identification of dioecious and monoecious varieties of hydrilla. Several of the deputies were able to view the infested fire control pond following the meeting.

Hydrilla identification and information pamphlets were also featured at a booth provided by the Nevada County Department of Agriculture at the Nevada County Fair. The CDFA supplied brochures and pictures of hydrilla for the booth. The public was asked to report any sighting of hydrilla to the Nevada County Agricultural Commissioner. No reports have been made.

SHASTA COUNTY

The Shasta County Hydrilla Eradication Project (Shasta Project) is a cooperative effort between the CDFA and the Shasta County Department of Agriculture. The Shasta Project began in 1985 after the dioecious form of hydrilla was detected in seven ponds located next to the Sacramento River. Due to the close proximity of the river and the potential threat to California water systems, the Governor of California issued a "Proclamation of Emergency" to facilitate eradication efforts. Surveyors in 1986 detected hydrilla infestations in four additional ponds. The CDFA convened a Scientific Advisory Panel in 1986, which recommended a survey, treatment, and public education program (Stocker, R.K. and L.W.J. Anderson *et al.* 1986). Based on these recommendations, Shasta Project crews chemically treated and filled in with soil four of these 11 ponds. Shasta Project biologists also treated the remaining seven ponds with herbicides for several years. By 2000, surveys showed that no hydrilla plants were detected in these 11 ponds and the CDFA considers hydrilla to be eradicated at these locations. However, in 1994, hydrilla was detected in two interconnected ponds in Anderson River Park, and in 1996 hydrilla was detected in a pond system at the Riverview Golf Course in Redding (Plate 8). A treatment program consisting of aquatic herbicides was initiated. Final surveys of the Anderson River Park ponds were conducted in 2004 and no hydrilla plants were found, and the CDFA now considers hydrilla eradicated from these ponds. Therefore, the Riverview Golf Course pond system was the only active hydrilla project remaining in Shasta County at the end of 2004.

Plate 8. Map Showing Remaining Hydrilla Infested Ponds in Shasta County.



Eradication of Hydrilla from the Anderson River Park Ponds

No hydrilla has been detected in the two Anderson River Park ponds since 1999. The ponds were treated with fluridone slow release pellets and surveyed in 1999, 2000, and 2001; they were surveyed intensely in 2002, 2003, and 2004, but not treated, as per the eradication protocol and Best Management Practices. In addition to shore and canoe based surveys, in October 2002, the CDFA contracted a crew of divers from the Shasta County Sheriff's posse to dive the large pond and survey for hydrilla. None was detected. In 2003, only shore and canoe based surveys were done and no hydrilla was detected. In 2004, both ponds were surveyed again by divers and by shore and canoe based surveys. The ponds were surveyed ten times between May 17 and October 22, 2004. Six weeks prior to the last survey, the Shasta County hydrilla crew treated water primrose that was encircling the large pond with triclopyr herbicide to

improve visibility and allow access to the pond edges. The last survey was very intense, and was conducted by a crew in a canoe and by a crew of divers. The crew in the canoe surveyed the entire pond by visual inspection and by repeated probing with a modified grappling hook. The divers focused on previously infested areas of the pond, where hydrilla was last detected in 1999. Neither survey crew detected any hydrilla. Following the final survey, the Shasta County Department of Agriculture and the Hydrilla Eradication Program worked with the CDFA Permits and Regulations Program and the Pest Exclusion Branch to remove the Anderson River Park from the hydrilla quarantine zone in Shasta County. This was completed on November 30, 2004[33].

Survey of Riverview Golf Course Ponds

The Riverview Golf Course infestation consists of four interconnected ponds. The most upstream pond, which is approximately 30 surface acres in size and is adjacent to the golf course, is fed from a small canal from the Sacramento River. The next three ponds are on the golf course, and are approximately six, two, and one acres, respectively, in surface area. Water returns to the Sacramento River along a small stream leading from the one-acre pond to the levee. The one-acre pond and small stream often go partially or completely dry in the late summer. When Shasta Project crews first surveyed these ponds in 1996, they found the 30-acre pond to be infested in the lower 15 acres where the infestation ranged from scattered single plants to small clumps, the six-acre pond to be moderately to heavily infested, and the two small ponds to be heavily infested.

In 2004 the Shasta hydrilla crew surveyed the first and largest pond, Rother's Pond, seven times between May 17 and October 6 by canoe and shoreline survey. Surveys used both visual inspection and repeated probes with a modified grappling hook. The water temperature at the time of the first survey was approximately 19 degrees C (66 degrees F), and at the time of the final survey approximately 22 degrees C (72 degrees F). No hydrilla plants were detected (Table 8). This compares to only one hydrilla plant detected in 2003. Other aquatic vegetation detected during these surveys included water primrose, Carolina fanwort (*Cabomba caroliniana*), elodea, and egeria.

Table 8. Number of Hydrilla Plants and Tubers Found and Removed from Redding Ponds, Shasta County 2000 - 2004.

	YEAR	2000	2001	2002	2003	2004
Rother's Pond	Plants	1	9	18*	1	1
	Tubers	0	0	0	0	0
Riverview Golf Course Ponds 1, 2, 3	Plants	32*	31	10	0	0
	Tubers	0	0	75**	0	0

*Estimated from narrative descriptions.
**Dredging operation in 2002 in main infested area; no dredging done in other years.

In 2004, the crew also surveyed the six-acre, two-acre, and one-acre ponds seven times between May 17 and October 7. The water temperature at the time of the first survey was 22 degrees C, and at the time of the final survey the ponds were dry. No hydrilla was found in the three smaller ponds. Other aquatic vegetation detected included algae,

[33] For a complete description of the new quarantine zone boundaries, see the CDFA Plant Quarantine Manual, State Hydrilla Interior Quarantine, Section 3410.

water primrose, elodea, egeria, and cattail. This is the second year in a row that no hydrilla has been detected in these ponds (Table 8).

Treatment of Riverview Golf Course Ponds

Because hydrilla was detected in Rother's Pond in 2003, it was treated in 2004 with five applications of fluridone slow release pellets, for a total application rate of 130 ppb[34]. In order to keep the concentration of fluridone in the water column as near the Beneficial Use Protective Water Quality Limit of five ppb, and still control any emerging hydrilla plants, the first application was made at 50 ppb and the subsequent applications at 20 ppb. The five application dates were June 3, June 24, June 15, August 5, and September 2. A total of 52 pounds of fluridone active ingredient were applied.

Because hydrilla was detected in one of the three smaller ponds in 2003, they were treated in 2004 with five applications of fluridone slow release pellets at 20 ppb each application, for a total application rate of 80 ppb. Applications were made on the same dates as those made to Rother's Pond, June 3, June 24, June 15, August 5, and September 2. A total of 6.5 pounds of fluridone active ingredient were used in 2004.

Environmental Monitoring of Riverview Golf Course Ponds[35]

Starting in June and for most of the treatment season, the Riverview Golf Course pumped irrigation water from the Sacramento River in order to avoid using fluridone treated water from Rother's Pond[36].

Survey Inside and Outside the Quarantine Zone[37]

Shasta Project biologists believe that hydrilla has appeared in the Redding area on three separate occasions (1985, 1994, and 1996) and are concerned that it might appear again. Accordingly, they maintain an intensive survey program inside and outside the quarantine zone. The quarantine zone is a corridor one mile wide on either side of the Sacramento River from the Redding Civic Center to the Red Bluff Diversion Dam. This zone includes 17 ponds, one creek, and six sections of the Sacramento River (Appendix IIIa). In 2004 these ponds, creeks and section of river were all surveyed at least twice (the creeks are surveyed between one-half mile above and one-half mile below road crossings, and the river is surveyed at 13 access points). No hydrilla was detected.

Outside the quarantine zone, Shasta Project personnel routinely survey another 26 ponds, lakes, and creeks (Appendix IIIb). In 2004, all areas were surveyed at least once. No hydrilla was detected.

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[34] Rother's Pond is large enough to qualify for a higher total seasonal application rate (150 ppb) than the smaller ponds (90 ppb), as per the Sonar® SRP label.

[35] This is not including monitoring done in compliance with the National Pollution Discharge Elimination System. See separate report for this information.

[36] In 1996, the golf course superintendent was concerned that fluridone treated irrigation water might injure the turf or ornamentals on the course. For this reason, Rother's Pond was not treated with fluridone in 1996 in order to avoid any possibility of phytotoxicity. The golf club developed an alternate water source in 1997, and fluridone has been applied to the pond since 1997.

[37] Hydrilla infested counties are "Eradication areas" by California Code of Regulations, Section 3962. "Quarantine zones" are reduced areas within "Eradication areas" and are the specific water bodies in the county where there are restrictions as to water access or use, as per California Code of Regulations, Section 3410.

Public Information and Awareness

Project biologists made their presentations to the public about the Shasta Project. Project crews distributed approximately 400 hydrilla brochures to bait shops, marinas, and recreation areas around Lake Shasta in the towns of Redding and Anderson, including the Coleman Fish Hatchery. In addition, the CDFA biologist gave a short presentation to the Coleman Fish Hatchery staff on hydrilla identification and the importance of eradication.

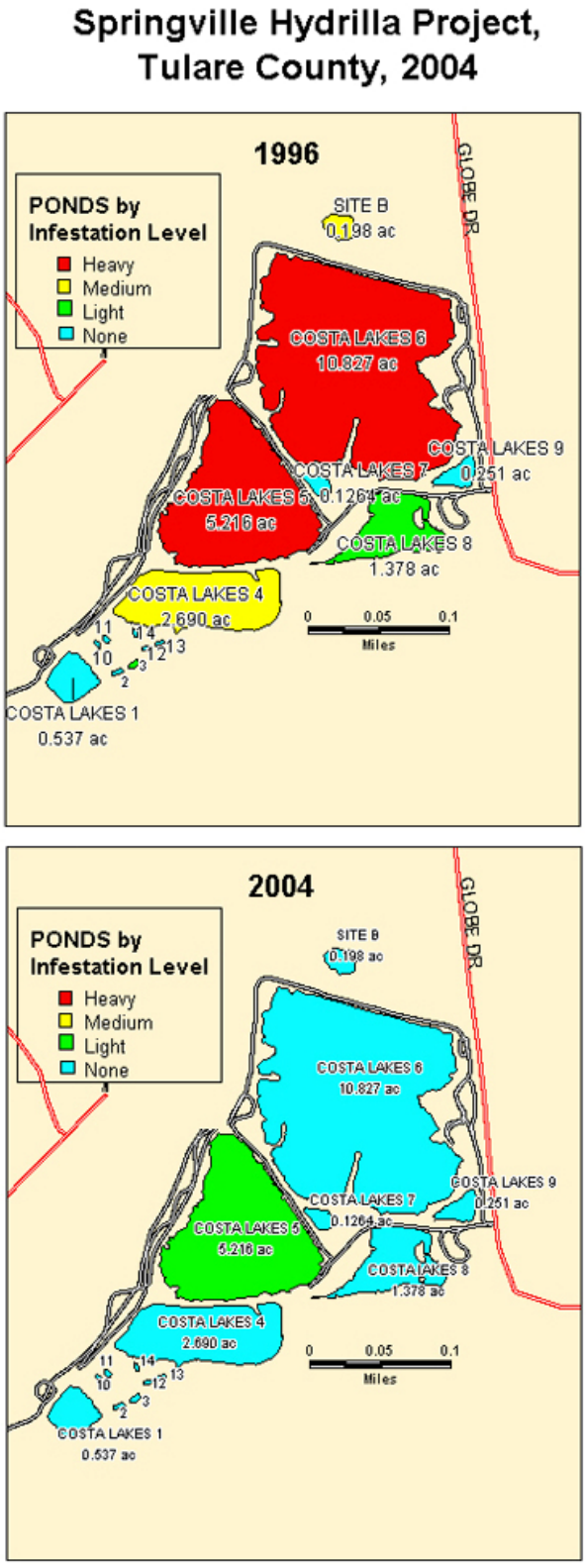
TULARE COUNTY

There have been two separate infestations of hydrilla in Tulare County. In 1993, a Tulare County Department of Agriculture biologist detected monoecious hydrilla in three small ponds that belonged to an ornamental, wholesale nursery near Visalia. The CDFA and Tulare County biologists, with the cooperation of the owner, emptied the ponds to dry out the hydrosoil and dry out the tubers, and then fumigated the hydrosoil with metam-sodium to control the plant tubers. The ponds were never re-charged with water and remain dry to this day. The CDFA crews continued to survey these ponds for several years, but no hydrilla was ever found. The CDFA considers the hydrilla in these ponds to be eradicated.

On October 7, 1996, dioecious hydrilla was detected in a fishing resort southwest of Springville in Tulare County (Plate 9). This resort is adjacent to the Tule River and is approximately two miles upstream from Lake Success[38]. The Tulare County Hydrilla Eradication Project (Tulare Project), which is a cooperative effort between the CDFA and the Tulare County Department of Agriculture, began soon thereafter.

[38] Lake Success is a 2,450-acre reservoir managed by the United States Army Corps of Engineers and is used primarily for flood control and agricultural purposes, although it is also popular for recreation.

Plate 9. Map Showing Change in Hydrilla Infestation at the Springville Ponds from the Year of First Detection, 1996, to Current Year, 2004.



Delimitation surveys by project crews determined that five ponds were infested on the resort and one pond was infested on an adjacent, downstream property. The infested ponds ranged in size from 0.02 acres to 10.8 acres with a total surface area of all ponds being 20 acres (Plate 9). The infestations in the ponds ranged from very dense to just a few scattered plants. Four other non-infested ponds were also on the resort's property. Additional ponds have been created since the initial hydrilla detection. Most of these are relatively small (less than 0.1 acre) and are used for fish breeding. There are now a total of 15 ponds on the resort property.

Survey and Treatment of the Springville Ponds

Project crews surveyed all 15 ponds on the resort property and the one previously infested pond off the property between six and 25 times in 2004 (pond 5 was surveyed 25 times). The first survey was on April 26, when the water temperature was 24 degrees C (76 degrees F). The last survey was on November 23, when the water temperature was 14 degrees C (57 degrees F). Originally in 1996, there were five infested ponds; last year, no hydrilla was found in any of the ponds, but this year, ten mats of hydrilla were found in pond 5 (Plate 9, Table 9). Because of high algae and blue-green algae blooms in the pond, the water is quite turbid and visibility for surveys is poor. In 2005, an underwater camera will be used to help identify the location of the hydrilla infestation in pond 5. Other aquatic vegetation detected in these ponds included curly leaf pondweed, chara, common waterweed, mosquitofern, water primrose, duckweed, spiny naiad (*Najas* species), southern naiad, cattail, and algae.

Table 9. Number of Rooted Hydrilla Plants and Tubers Found and Removed from the Springville Ponds, Tulare County 2000 – 2004.

YEAR	2000	2001	2002	2003	2004
Mats	0	0	0	0	10*
Plants	9**	37***	0	0	0
Tubers	1,749***	243***	0	0	0

*Pond 5 only.
**Ponds 5 and 6.
***Pond 6 only.

Since the project began, the eradication treatments used have included hand removal of plants, copper and fluridone herbicides, and small-scale dredging of tubers. In 2004, project crews applied fluridone liquid and fluridone slow release pellets to ponds 4, 5, 6, and 8. Pond 4 was treated because the water from it flows into pond 5 and could be the source of the hydrilla; pond 5 was infested in 2004; pond 6 was infested in 2001[39];and pond 8 is in the last year of the three-year treatment cycle. Pond 5 was treated with a combination of pellet and liquid formulations of fluridone for a cumulative total of 90 ppb. A total of 48 pounds of fluridone active ingredient were applied in all project ponds.

[39] Fluridone liquid is used where the pond bottom is heavy clay and organic sediment. Fluridone slow release pellets are used where the pond bottom is solid (granite).

Surveys Outside of the Quarantine Zone

In 2004, Tulare Project crews surveyed Lake Success and 10 surrounding small ponds in the area of the infested ponds. Surveys were conducted by boat, canoe, and hiking. No hydrilla was detected.

YUBA COUNTY

Yuba County has had three distinct hydrilla infestations: Lake Ellis, Shakey's Pond, and Oregon House. The first two infestations have been eradicated. The first infestation was the dioecious form of hydrilla in Lake Ellis, a 31-acre ornamental lake in the center of Marysville. Hydrilla was found in Lake Ellis in 1976, the first occurrence of hydrilla found in California. In 1979, the lake was drawn down, the hydrosoil removed, and the infested areas treated with metam-sodium. Six plants re-appeared in 1980 in one small location. Project biologists then treated the entire lake with endothall and copper ethylenediamine complex with special attention paid to the infested location. By 1981, the lake was free of hydrilla and eradication was declared in 1984. The second infestation was discovered in 1990 in Shakey's Pond, which may have become infested as a result of hand carrying infested plant material to it from Lake Ellis in the 1970s. Hand removal and aquatic herbicide treatments reduced the number of plants until only one plant was found in 1996, when the pond received three treatments of fluridone. No plants have been found in the pond since 1996, and this infestation is also considered eradicated.

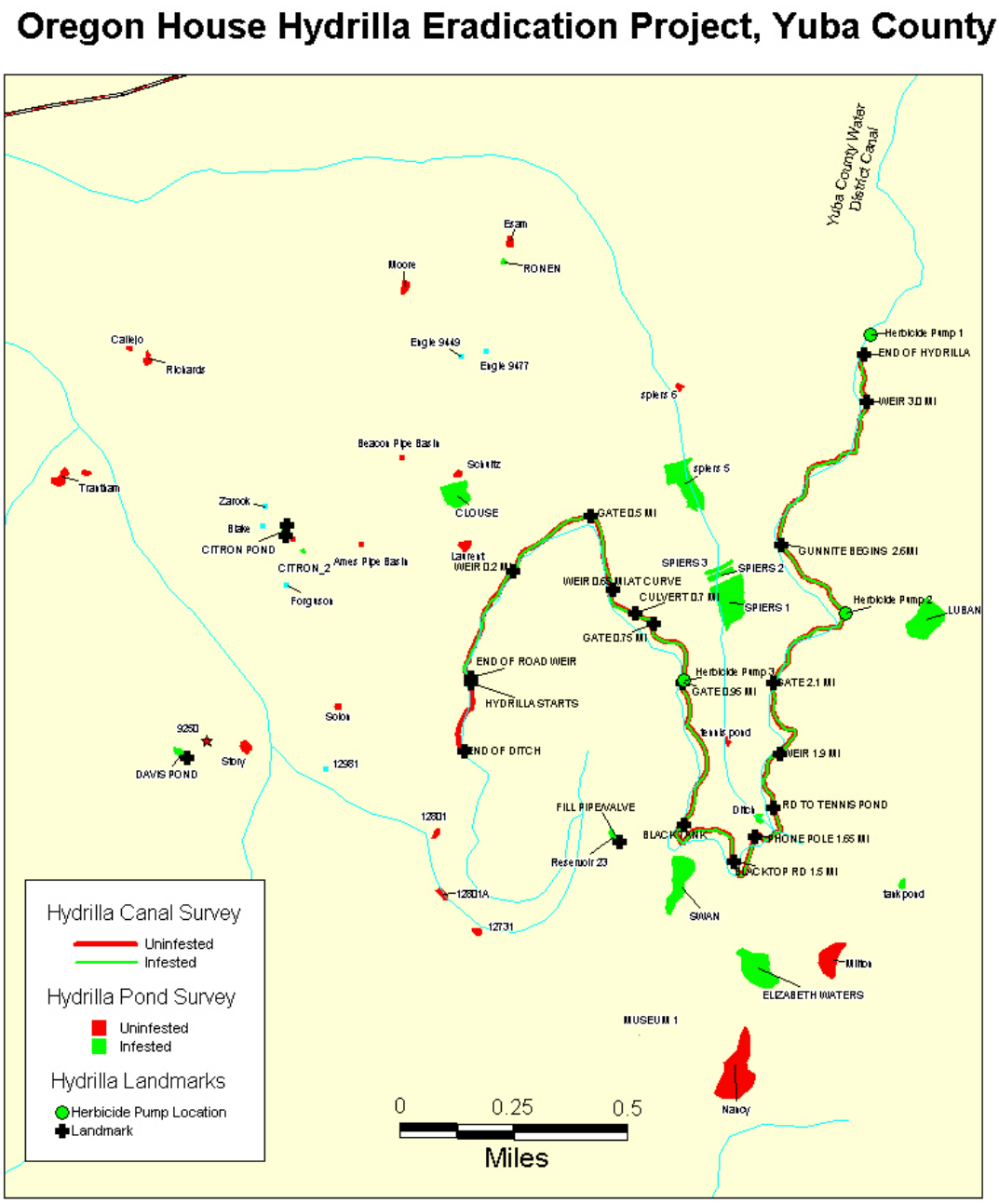
Oregon House: The On-Going Eradication Project

On August 7, 1997, a third infestation of hydrilla was detected in Yuba County near Oregon House (Plate 10). A visitor to a nearby winery suspected that hydrilla had infested one of the ponds on the winery and reported this suspicion to the Yuba County Department of Agriculture. Yuba County biologists investigated, found hydrilla, and sent a sample to the CDFA Plant Pest Diagnostics Lab for confirmation. The CDFA Plant Pest Diagnostics Lab confirmed the specimen to be hydrilla. Scientists at the United States Department of Agriculture-Agricultural Research Service Exotic and Invasive Weed Unit then confirmed it to be the monoecious form of hydrilla.

The Oregon House Hydrilla Eradication Project (Oregon House Project), which is a cooperative effort between the CDFA and the Yuba County Department of Agriculture, was started after this first detection. Biologists conducted delimitation surveys at the winery and found that a total of five ponds (ranging from 0.15 to 3.0 acres in size and nine feet to 13 feet deep) and an ornamental fountain[40] were infested (Plate 10). Two of the ponds, Ditch Pond and Tank Pond, are used to irrigate the vineyard. Project crews then conducted delimitation surveys within the three-mile quarantine zone (around the known infested ponds) and detected additional infestations on three private properties, the Spiers 1, 2, and 3 ponds (3.8, 0.5, and 0.4 acres) and the Clouse and Ronen ponds (1.9 and 0.1 acres) (Plate 10). The two smaller Spiers ponds were used for rearing catfish. Another 40 ponds were surveyed and found not to be infested.

[40] The infested water lilies in the ornamental fountain were removed, the hydrilla plants and tubers destroyed, and the water lilies repotted and returned.

Plate 10. Map Showing Hydrilla Infested Ponds Near Oregon House and Hydrilla Infested Extent of Yuba County Water District Canal.



In 2000, project survey crews, during routine surveys, detected three additional infested ponds. These were Reservoir 23 (0.25 surface acres), Davis Pond (0.37 acres), and Citron Pond (0.22 acres) (Plate 10). Reservoir 23 is also used for irrigation at the winery.

In 2003, a single hydrilla plant was detected in Spiers Pond 5. This pond had been surveyed multiple times per year since the beginning of the project. Project biologists believe that the most probable route of infestation for this pond may have been a plant fragment floating down via a small creek from Spiers Pond 1.

Survey of Ponds Within the Quarantine Zone

In 2004, project biologists detected hydrilla in two of the three ponds used for irrigation by the winery, Ditch Pond and Tank Pond (Table 10). Only one plant was detected in Tank Pond, but Ditch Pond had several plants at several survey times during the season. Ditch Canal is directly filled from the Yuba County Water District Canal and is downstream of one of the most heavily infested areas in the canal. No hydrilla was detected in the third pond used for irrigation, Reservoir 23, though it has been infested in past years. All three ponds were surveyed a minimum of six times during the year. Other aquatic vegetation noted during the surveys included nitella (*Nitella* species) and chara (*Chara* species), both forms of algae.

In the eleven ponds not used for irrigation, hydrilla was detected in one of them, Spiers 2. Spiers 1 was only lightly infested, but in Spiers 2 hydrilla appeared in three locations, one of which was a large mat. Several ponds, Davis, Elizabeth, and Swan, have not had any detections in the past four years (Table 10). In 2005, these ponds may not be treated with aquatic herbicide unless hydrilla plants are detected. In any case, they will be monitored for at least another three years. All eleven ponds were surveyed at least three times during the year. Other aquatic vegetation noted during the surveys included nitella and chara, both forms of algae.

Table 10. Presence (+) or Absence (-) of Hydrilla Plants or Tubers in the Yuba Ponds Near Oregon House, Yuba County 2000 – 2004.

Hydrilla Detections (Plants or Tubers) in the Yuba County Ponds							
			YEAR				
Pond Type	Pond Name	Pond Size (Acres)	2000	2001	2002	2003	2004
Irrigation	Ditch	0.2	+	+	+	+	+*
	Reservoir 23	0.3	+	+	+	+	-
	Tank	0.2	+	+	+	+	+
Non-Irrigation	Citron	0.2	+	+	+	+	-
	Clouse	1.9	-	-	+	+	-
	Davis	0.4	+	-	-	-	-
	Elizabeth	3.1	+	-	-	-	-
	Luban	3.0	+	-	+	+	-
	Ronen	0.1	-	dry	dry	+	-
	Spiers 1	3.8	+	+	+	+	-
	Spiers 2	0.5	-**	+	dry	dry	+
	Spiers 3	0.4	-**	dry	dry	dry	-
	Spiers 5	3.5	-	-	-	+	-
	Swan	2.7	-	-	-	-	-

*Dredging operation found and removed 416 tubers from Ditch Pond in 2004.
**Owner drained Spiers 2 and 3 during Winter 2000.

Treatment of Ponds Within the Quarantine Zone

In 2004, the three irrigation ponds, Ditch Pond, Tank Pond and Reservoir 23, were treated with one ppm copper ethylenediamine four times between May 12 and October 14. In these three ponds, a total of 45.6 pounds of copper active ingredient were used. In addition, in September and October, Ditch Pond was dredged for tubers using a modified gold dredge. A total of 416 tubers were recovered. Project biologists suspect that there are many more tubers in the hydrosoil in the pond, and additional dredging is planned for 2005.

The eleven non-irrigation, infested ponds were treated two times with fluridone slow release pellets at 30 ppb each application. The ponds were treated twice between May 11 and October 7. A total of 31 pounds of fluridone active ingredient were used in all the ponds.

The Yuba County Water District Canal

While surveying the Oregon House area in 1997, CDFA and Yuba County biologists found that the lowest 3.1 miles of an 18-mile irrigation canal, owned by the Yuba County Water District, was infested with hydrilla (Plate 10). In addition, two other small water impoundments, which are fed from the canal, were also found to be infested (Ames, 0.01 acres and Beacon, 0.02 acres). The canal is in operation between April and October. For the reason that the irrigation canal is the headwaters of the entire infestation, eradication of hydrilla in the canal is pivotal to the success of the entire Oregon House Project, including eradication from the ponds.

In 1997, 1998, and 1999, several eradication methods were tried in the canal, with varied results. Starting in 2000, Oregon House Project biologists have used a flowing-water copper application method with good results. After a successful preliminary test in mid-summer 2000, they have used electric pumps at three stations one mile apart to meter copper ethylenediamine herbicide into the flowing water of the canal for six hours. The rate of metering of copper ethylenediamine complex decreased sequentially from station to station to maintain a one-ppm concentration of copper in the water. Visual observations in 2000 showed that this method proved to be very effective in controlling the hydrilla top growth and the method was adopted. Also in 2000, project biologists started raking[41] the canal, which has proven in the last three years to be very effective, though labor intensive and time consuming. In 2001, an acetic acid treatment was tried with promising results (Spencer, D and G. Ksander, 2001).

Starting in September 1998, Dr. David Spencer and Greg Ksander from the United States Department of Agriculture-Agricultural Research Service-Exotic and Invasive Weed Unit have made periodic estimates of the tuber distribution in the canal by counting the number of hydrilla tubers in core samples from the canal bottom (Table 12). In addition, starting in September 1998, CDFA biologists have made visual estimates of the hydrilla density in the canal. Visual estimates are made in the late summer to fall, just before the next scheduled copper treatment, in order to give the hydrilla maximum opportunity to grow and be visible. These estimates of tuber and plant density have helped track the effectiveness of the treatment program.

Survey of the Yuba Water District Canal

Yuba County Project biologists have divided the upper two miles of the canal into management units measuring 50 meters in length starting from the upstream beginning of the hydrilla infestation. There are a total of 65 management units. The canal also includes two small holding ponds, Ames Pond and Beacon Pond, which are directly fed by the canal and hold water to be delivered to other properties. Several sections of the canal are lined with gunite. The hydrilla population in these sections is very low.

In 2004, project biologists conducted a visual hydrilla density survey of the canal on September 9. Visible hydrilla tended to occur in "hotspots" near the top third of the canal. At this time, the most highly infested areas, starting from the upper end of the infested area in the canal, were as follows: 600 meters to 710 meters down the canal, 1,200 meters to 1,420 meters, and 1,850 meters to 1,960 meters. A bottom two-thirds of the canal, from 2,000 meters to 4,900 meters, was very lightly infested.

For the two holding ponds, hydrilla plants were detected in Ames Pond in 2003 but not in 2004. The irrigation district dug this canal out with a backhoe. Beacon Pond is gunite lined and was cleaned out of all sediment and hydrilla by project biologists in January 2002, and no hydrilla has been detected since then.

[41] The rake method is simply to use a garden rake to sift the sediment in the canal bottom and sides to remove any hydrilla plants, tubers, roots, and root crowns. Screens are placed downstream of the raking operation to catch any floating hydrilla fragments.

Project biologists have noted a decrease in the number of tubers removed from the most highly infested management units over the past couple of years, indicating a continual decrease in the tuber bank. Table 11 shows the number of tubers removed from the top ten management units for the past three years. Similar results were found in the other management units.

Table 11. Number of Tubers Removed from Selected Management Units at the Yuba County Water District Canal.

YEAR	2002	2004
Unit 0	17	0
Unit 1	0	0
Unit 2	0	0
Unit 3	32	0
Unit 4	347	26
Unit 5	255	11
Unit 6	512	25
Unit 7	263	9
Unit 8	286	8
Unit 24	333	12
Unit 30	136	6

In contrast to the above decrease in the number of tubers removed from the canal, in the fall of 2004, Dr. David Spencer and Greg Ksander took core samples from the canal to estimate tuber density, as they have since 1998. The tuber density in these tuber core samples was 14 tubers per meter squared, as compared to two tubers per meter squared in the fall of 2003 (Table 12). However, 14 tubers per meter squared is a massive reduction from 316 tubers per square meter in 1998, and about equal to the 13 tubers per meter squared detected in the fall of 2002. The tubers in the canal are very unevenly distributed, and in 2004 they probably hit a few "hot spots."

Table 12. Tuber Abundance in the Oregon House Irrigation Canal, Yuba County 2000 - 2004. (D.F. Spencer & G.G. Ksander, USDA-ARS, Davis, CA)

YEAR	Fall-2000	Spring-2001	Spring-2002	Fall-2002	Fall-2003	Fall-2004
Mean Tubers/m^2	84	76	28	13	2	14
Standard Error	± 21	± 24	± 9	± 5	± 2	± 6

In addition to hydrilla, project biologists detected several other aquatic plants in the canal, including elodea pondweed and sago pondweed. In places, the population levels are quite high, making accurate survey difficult, and interfering with treatments. There is also a heavy algae load on the plants, which can complicate survey and treatment starting in mid summer unless controlled.

Treatment of the Yuba County Water District Canal

In 2004, the project biologist continued to combine raking and physical removal of individual plants with flowing-water copper herbicide treatments. The first hydrilla plant was visible in the canal on April 27. During the year, the project biologist removed over 4,000 hydrilla tubers and plants with tubers from the entire canal, and over 15,000 plants with root crowns but no tuber. Tuber removal efforts concentrated on infested management units not slated for acetic acid treatment (see below).

Four metered copper herbicide applications were made; the first was made on June 3 and the last was made on September 16 (Plate 11 for application locations). The last application was only made to the upper sections of the canal, as this is where the hydrilla infestation is highest. The target copper application rate in all applications was one ppm. Water samples were collected during the last application to monitor the application rate. In total, 44 pounds of copper active ingredient were applied to the canal in 2004. In mid October, the water district discharged the canal.

The weather cooperated in 2004 and project biologists and Dr. David Spencer and Mr. Greg Ksander were able to make an experimental acetic acid treatment to selected management units. In addition, the application method was changed to allow the application to be made in less than ideal conditions. Instead of adding large volumes of dilute acetic acid to sections of dry canal, the water in the canal was impounded in the target sections and acetic acid was added directly to the standing water. The application was made on November 2 to a heavily infested area encompassing parts of Management Units 45 and 48, and all of Management Units 46 and 47. Rain followed the application, but it is expected to be a good test.

SURVEY ONLY PROJECTS

THE SACRAMENTO/SAN JOAQUIN RIVER DELTA SURVEY

Each year since the mid 1980s, CDFA personnel have conducted a survey of the Sacramento/San Joaquin River Delta and the lower reaches of the tributary rivers for hydrilla[42] because hydrilla tubers or plant fragments could be introduced into the Delta by natural or human vectors[43]. The annual survey is conducted in the fall of the year when hydrilla plants would be most visible as they reach the water surface and form dense mats. The presence of other aquatic weeds is also noted. In 2003 and 2004, CDFA biologists assisted scientists from the Center for Spatial Technologies and Remote Sensing at the University of California, Davis and the California Department of

[42] The Sacramento/San Joaquin River Delta is one of the most important sources of fresh water in the State of California. The Delta carries 47 percent of all the runoff water in the state. It provides water for residential, industrial, and agricultural uses in both the north and south state areas. The Delta supports approximately 120 fish species, approximately 750 plant and animal species, and is the largest wetland habitat in the western United States (CALFED Bay-Delta Program 2001). Any blockage of this water-flow by hydrilla would impede navigation, clog water control structures, imperil native plant, fish, and animal life and diversity; and raise the cost of water delivery to users. The annual CDFA hydrilla survey of the Delta was partially initiated in response to recommendations made by the Scientific Advisory Panel convened in 1988 to consider the hydrilla infestation in Calaveras County (Stocker, R.K. and L.W.J. Anderson *et al.* 1988).

[43] Plant fragments, tubers, or turions from any active hydrilla infestation in California or elsewhere could potentially infest the Delta. Plant fragments, tubers, or turions could be carried into the Delta by direct hydraulic connection (water-flow) or by way of contaminated boats, boat trailers, boat motors, live wells, trucks, fishing gear, clothing, and other equipment. Of the active hydrilla eradication projects, the closest and most direct hydraulic connection to the Delta is the Hesseltine ponded area in Bear Creek in Calaveras County, which is about 26 miles upstream from Disappointment Slough near Stockton.

Boating and Waterways in developing remote sensing to measure and map aquatic weeds in the Delta, including hydrilla.

Survey of the Sacramento/San Joaquin River Delta

In 2004, CDFA crews, assisted by biologists from the San Joaquin County Department of Agriculture, surveyed the Delta from August 23 through September 3 and September 13 through September 17. A total of 386 miles of Delta waterways were surveyed (Plate 12). Surveys were conducted by visual inspection of the water column and by sampling submersed vegetation with modified grappling hooks when needed. Survey teams monitored their progress and position using GPS technology. The following areas were surveyed: Suisun Bay, Middle River, Old River, Frank's Tract, Potato Slough, White's Slough, Disappointment Slough, Bear Creek, Victoria Channel, Grant Line Canal, Discovery Bay, Italian Slough, Orwood Cut, Rock Slough, Empire Cut, Whiskey Slough, Turner Cut, Columbia Cut, Stockton Deep Water Channel, and the lower reaches of the Sacramento River and San Joaquin River. No hydrilla was detected. However, other non-native, aquatic pest plants, such as egeria, water hyacinth, Carolina fanwort, and Eurasian watermilfoil were detected, sometimes in large populations (Plate 11).

INSERT PLATE 11 (foldout page) HERE.

Cache Creek, which flows into Suisun Bay, was surveyed separately. CDFA crews surveyed Cache Creek for hydrilla while surveying for purple loosestrife. In 2004, Cache Creek was surveyed three times, on July 13, July 26, and August 17.

In 2004, the CDFA cooperated with the California Department of Boating and Waterways and Center for Spatial Technologies and Remote Sensing in conducting a remote sensing project to detect, quantify, and map Brazilian waterweed, water hyacinth, and other aquatic weeds in the Delta (Mulitsch et al. 2005). The method used was a hyperspectral sensor system on an aircraft platform[44]. Crews conducted water-based surveys in support of the aircraft survey between June 24 and July 2 with hand-held sensors on boat platforms.[45] The water-based surveys consisted of 2,103 sites in the Delta and associated rivers. At each site several parameters were measured including the weeds present (most sites were chosen because they had large solid patches of a weed of interest, though some mixed communities were also used). Plant samples were collected daily and submitted to the CDFA Botany Laboratory for positive identification. The submerged aquatic weed of primary interest was Brazilian waterweed; submerged aquatic weeds of secondary interest included common waterweed, Carolina fanwort, and Eurasian watermilfoil. The floating aquatic weed of primary interest was water hyacinth. There were several emersed aquatic weeds of secondary interest, including water primrose, pennywort (*Hydrocotyle ranunculoides*), cattails and tules (*Scirpus* species). For the purpose of this report, none of the crews visually detected or sampled any hydrilla at any of the 2,000 plus sample sites.

For both aerial and hand-held systems, the electromagnetic spectrum between 400 and 2,500 nanometers (visible, near-infrared, and short-wave infrared) was divided into 126 bands. Field measurements were geo-referenced using the GPS system[46]. Data analysis was done by the Center for Spatial Technologies and Remote Sensing (Mulitsch et al. 2005). Images were registered (geo-corrected) using United States Geological Survey orthophoto quadrats. Spatial resolution was approximately 3-meter by 3-meter pixels. The aircraft based sensor proved promising for the detection, quantification, and mapping of the water hyacinth, egeria, and other weeds. For purposes of this report, the preliminary conclusion of the researchers is that it may be possible to resolve submerged aquatic weeds using the technology, when the aquatic environment allows for adequate light penetration into the water column. Therefore, this technology might be of assistance in surveying for hydrilla in the Delta in the future.

SUMMARY AND CONCLUSIONS

2004 was a successful year for the CDFA Hydrilla Eradication Program in terms of both eradication progress and detection of new infestations. Program biologists continued to reduce the population of hydrilla at known, infested sites, and the quarantine zones in two counties were reduced in area. In addition, three new hydrilla occurrences were detected, in Alameda, Los Angeles, and Nevada counties. This emphasizes the importance of on-going surveys as potential hydrilla introductions could lead to the establishment of new infestations.

[44] The HyMap® System, HyVista Corporation. For more information, see Cocks, T., R. Jennsen, *et al.* 1998.
[45] Field portable spectrometer by Analytical Spectral Devices.
[46] Trimble® Pro-XRS with less than one-meter accuracy.

The CDFA Hydrilla Eradication Program has been a cooperative effort since the first discovery of hydrilla in Marysville in 1976. The Governor, Legislature, and the CDFA recognized the threat hydrilla posed for the State of California and quickly instituted the legal framework needed to eradicate this aquatic, noxious weed. With the operational and technical support of many cooperators, the CDFA Hydrilla Eradication Program has been successfully conducting survey, eradication, and public education efforts ever since.

Starting with the original, infested site at Lake Ellis in Marysville several decades ago, the CDFA has been aggressively eradicating hydrilla from all known sites. Many of the current infestations are approaching eradication. In 2004, the quarantine zones were reduced in area in Shasta County and in Imperial County, demonstrating the on-going success of the eradication programs in both counties. In the remaining infestation in Shasta County, only one hydrilla plant was found in 2004. In Clear Lake in Lake County, no hydrilla plants were found for the first time since the program began there in 1994. In addition, no hydrilla plants were detected in Eastman Lake or the Chowchilla River for the second year in a row. Hydrilla was detected in only one pond in the Tulare County infestation, and there was only one infested drain in Imperial County. In addition, plant populations and tuber counts are decreasing in the Yuba County Water District Canal and associated ponds. Only two plants and two tubers were detected in Bear Creek in Calaveras County, though plants continue to be found in the stock pond near Mokelumne Hill.

CDFA survey crews continue to guard against new hydrilla introductions. The CDFA is dedicated to finding any new introductions in California in an early and relatively easy-to-eradicate growth stage. In 2004, thanks to the diligence of CDFA and county biologists and inspectors, two infested aquatic plant nurseries were discovered: the first in Los Angeles County and then later in the year in Alameda County. In addition, thanks to the public outreach and education program, a company representative recognized hydrilla in a third new site in Nevada County. CDFA and county biologists began clean up and eradication efforts at all three sites immediately after discovery.

CDFA and county biologists continue to survey the environmentally sensitive Sacramento/San Joaquin River Delta. Once again, CDFA survey crews detected no hydrilla plants in the Delta in 2004. In addition, the CDFA continues to work with cooperating agencies and researchers to develop new and more efficient survey technologies for hydrilla and other invasive plants in the Delta.

In conclusion, the CDFA's Hydrilla Eradication Program is helping to protect California's waterways by keeping them free of the invasive, noxious, aquatic weed, hydrilla. Continued diligence in survey and public outreach, and rapid response to any new detection is key in the success of this effort. The CDFA Hydrilla Eradication Program would like to thank its supporters and cooperators for aiding in the success of this program.

COOPERATORS

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